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MONTANA DEPARTMENT OF FISH, WILDLIFE & PARKS

MONTANA MOUNTAIN GOAT INVESTIGATIONS

ROCKY MOUNTAIN FRONT

FINAL • AUGUST 1986

PREPARED BY GAYLE JOSLIN

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In Cooperation With
U.S. Fish and Wildlife Service
Bureau of Land Management

August 1986

MOUNTAIN GOAT
(Oreamnos americanus)

(photo courtesy of Montana Travel Promotion Bureau)

ABSTRACT

Management recommendations involving seasonal restrictions on human activities within mountain goat habitat are based on mountain goat seasonal habitat maps and the endorsed Interagency Rocky Mountain Front Wildlife Guidelines. Twenty-three radio-marked mountain goats captured at the Blackleaf mineral lick and 1 captured at Our Lake provide seasonal and yearlong home range information. Females are more faithful to their home ranges than are males based on average distances between yearly geographic activity centers. Individual home range sizes varied from 16.0 to 64.5 km² for adult females and from 22.9 to 181.5 km² for adult males. Summer ranges of 7 adult females and 9 adult males averaged 19.2 and 48.5 km², respectively, and winter ranges averaged 22.2 and 46.4 km², respectively. Approximately 24 percent of the study area, and 79 percent of the Teton-Dupuyer segment, is used by the 23 goats captured at the Blackleaf lick. Association tests of marked goats illustrate relative degree of association between sexes and age classes. Population distribution appears to have changed little over the past 30 to 50 years, although population levels have declined in some areas. Two habitat islands in the Badger Creek area could be severed from the main body of mountain goat habitat as energy exploration activity continues to increase. A population estimate for the area from the Middle Fork Teton to the divide between South Fork Birch Creek and North Fork Teton and North Fork Dupuyer, ranged from 53 to 113, resulting in a density of 1 goat per 5.3 to 2.5 km². Trends in kid:adult and subadult:adult ratios, along with total survey figures, suggest a population decline in the Birch-Badger and Teton-Dupuyer segments of the Front, from 1981 to 1985. Historical mountain goat distribution and population level information along the Front is reviewed. Bighorn sheep/mountain goat range overlap, social interactions, forage selection, and ecological relationships are discussed. Discriminant analysis of environmental variables revealed that slope and elevation are the most important factors to mountain goats in selecting seasonal habitat. Physiography of the area was compared using Chi-square analysis. A gradient in topographic features and climate exist from north to south. Seventeen mineral licks were recorded. Seven months of food habits information from both feeding site exams and fecal analysis indicate the use of shrubs, grass and forbs during late winter and spring, then the order shifts to forbs, grass, and shrubs through the summer. Over 670 km of seismic lines have been shot in mountain goat habitat along the Rocky Mountain Front since 1981. About 104 km of road exist on the study area. Current AUM allocations on livestock grazing and outfitter packstock allotments and Forest Service administrative units total about 4,710. Five million board feet of timber are planned for harvest over the next 10 years. About 30 percent of the study area has burned in the past 100 years. Two hunting districts involving 8 permits occur north of the Middle Fork Teton River. Information collected over the course of this project has been used to develop the mountain goat portion of the Rocky Mountain Front Interagency Wildlife Guidelines.

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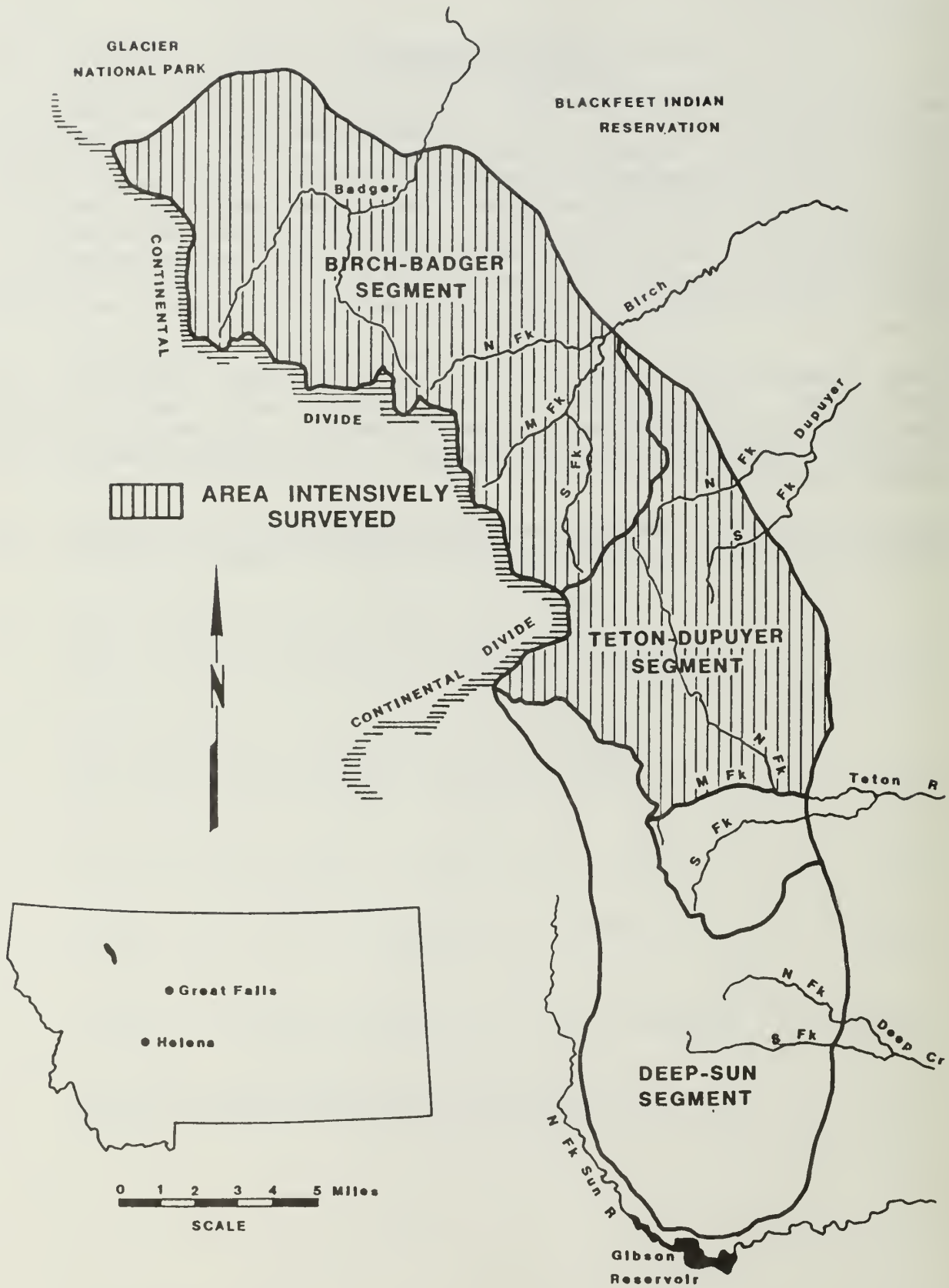

Rocky Mountain Front Study Area

INTRODUCTION

Montana maintains one of the largest populations of mountain goats in North America. Over 95 percent of mountain goat habitat in the state occurs on lands administered by the U. S. Forest Service. Interest in the development of natural resources on National Forest land is intensifying, and with the development come associated increases in human activity. Mountain goat research in North America has demonstrated that this species is particularly vulnerable to activities of man. Locally, their populations have declined or disappeared in areas of Montana, Idaho, Washington, South Dakota, Alaska, British Columbia, and Alberta due to mining (Brandborg 1955, Pendergast and Bindernagle 1977, McCallum 1983, Ritchie and Watts 1984, Smith and Nichols 1984), logging and road access (Chadwick 1973, Joslin 1980, Phelps et al. 1975, Kerr 1965, McFetridge 1977, Merriam 1965, Ballard 1977, Johnson 1983, Alaska Department of Fish and Game 1975 and 1976, Schoen and Kirchoff 1981) and recreation (Rice and Benzon, 1985).

The east slope of the Rocky Mountains provides habitat for one of the largest contiguous populations of mountain goats in the state. This area has recently experienced a surge of oil and gas exploration activity, as well as impacts from other commodity extraction and recreational demands. The recent interest in oil and gas development potential began in the 1980's. Between 1981 and 1985 about 1,425 km (891 miles) of seismic line was shot along the Rocky Mountain Front. The Rocky Mountain Front (RMF) is rich in wildlife diversity and abundance. In an attempt to avoid or minimize negative impacts from energy exploration and other disturbance, state and federal agencies and private organizations felt it necessary to initiate intensive work along the Rocky Mountain Front to gather information about wildlife population status, habitat use, and response to human activities. During the past few years, research on the RMF has been initiated on mountain goats, grizzly and black bears, bighorn sheep, elk, mule deer, and raptors.

Mountain goats are native to the Rocky Mountain Front. The first investigations of this population were conducted by the Montana Department of Fish and Game (MDFG) from 1946 to 1948 (Casebeer et al. 1950). Aside from occasional aerial surveys by the MDFG, no other study of this population was conducted until 1978, when a graduate thesis (Thompson 1980) was initiated to provide an update to the early 1950's information. A brief follow-up to this endeavor was conducted by Tomasko (1980). The study area and scope of study were expanded in 1981 to provide information for the entire RMF and to monitor the response of mountain goats to energy exploration.

The goal of this investigation is to ensure the continued survival of a healthy, viable mountain goat population from the Sun River to Badger Creek while recreation and development take place in the same country. The Rocky Mountain Front Interagency Executive and Technical Committees were in part established to pursue this goal.

This project has been conducted under the auspices of the Rocky Mountain Front Interagency Executive Committee with cooperative funding during this report period from the U.S. Fish and Wildlife Service (contract 14-16-0006-81-078), the Bureau of Land Management (contract MT 950-CT5-010), and the MDFWP. Prior to 1985 project support was provided, in part by the Lewis and Clark National Forest, the U.S. Fish and Wildlife Service, the Allen Foundation, and industry contributions from American Petrofina Inc., ARCO Exploration Company, Shell Western E and P, Inc., Sun Exploration Company, and Superior Oil Company.

In order to develop recommendations needed by both wildlife and land managers to minimize human disturbance to mountain goats and their habitat along the Rocky Mountain Front, the objectives of the project were to:

1. delineate individual population segments of the Rocky Mountain Front mountain goat population;

2. determine the population status, trend and distribution of each segment;

3. determine seasonal ranges including kidding-nursery, breeding, and yearlong habitats, and mineral lick sites; and

4. monitor population parameters and habitat use between segments and through time in order to detect changes in response to human activity.

This report combines information from previous reports (Joslin 1981, 1982, 1983, 1984, 1985). In addition, it includes present and historic information on mountain goat distribution and relative abundance, comparative habitat analysis of mountain goat population segments, discussion of potential for inter-specific competition, explanation of recent population trends utilizing computer modelling techniques, description of human activity within the study area and the possible consequent impacts upon mountain goats, and an annotated bibliography of selected literature relavent to mitigating or compensating impacts of human activities upon mountain goats. It also summarizes and augments management guidelines which have been endorsed by the Interagency Executive Committee. This is the final report of this project.

STUDY AREA

The Sawtooth Range of northcentral Montana extends from the Canadian border through Glacier National Park to the Dearborn River. The eastern portion of this range is known as the Rocky Mountain Front since faults and thrusting of sedimentary rocks have created north-south mountain reefs which rise abruptly from the prairies and line up in parallel ranks back to the

Continental Divide. The Rocky Mountain Front mountain goat study area occupies approximately 1,298 km² (500 mi²) in the center one-third of the Sawtooth Range. The study area was divided into 3 segments based on physiography and mountain goat distribution. The northern segment encompasses an area of approximately 530 km² (204 mi²) drained by Birch, Badger and Two Medicine creeks. The center Teton-Dupuyer segment covers approximately 385 km² (149 mi²) and is drained by the Teton River and Dupuyer Creek. The southern segment includes 382 km² (147 mi²) east of the North Fork of the Sun River, which is drained by the Sun River, Deep and Willow creeks.

The Rocky Mountain Front is a portion of the Sawtooth Range (photo by Kristi DuBois)

Most of the study area (95.3 percent) occurs on land administered by the Lewis and Clark National Forest. Minor amounts occur on Bureau of Land Management (BLM) (1.8 percent), State of Montana (1.4 percent), and private lands (1.5 percent).

The highest point on the study area is Rocky Mountain at 2863 m (9392 ft), which lies at the head of the South Fork Teton. The study area boundary, as outlined in the study area map, is approximately defined by the 1830 m (6000 ft) level.

Precipitation ranges from 38 cm (15 in) on the eastern prairie border to over 200 cm (80 in) in the alpine where 60 to 80 percent falls as snow. Weather data from east, north and south of the study area at Blackleaf, East Glacier and Gibson Dam reporting stations (National Oceanic and Atmospheric Administration 1980-1984) are presented in Appendices 1, 2, and 3.

Average snow depths (March, April, and May combined) from 4 snow survey sites (USDA SCS 1922-1985) along the RMF (Figure 1), indicate an increasing gradient from south to north. The Goat Mountain (south of the Sun River) site has the lowest average snow depth of 83.2 cm, while the Badger Pass site has the highest average snow pack of 248.3 cm.

Vegetation structure of the Rocky Mountain Front is complex. Rough fescue (Festuca scabrella)/Idaho fescue (Festuca idahoensis) grassland at the eastern edge of the study area merges with open stands of limber pine (Pinus flexilus)/shrubby cinquefoil (Potentilla fruticosa) in the foothills. The limber pine grades into thicker stands of mixed Douglas fir (Pseudotsuga mensiezii), limber pine, Englemann spruce (Picea engelmannii), and lodgepole pine (Pinus contorta) at the base of the reefs and on the reef plateaus.

As successive sets of cliff and plateau stair-step upward, the mixed conifer forest gives way to parkland composed of scattered limber and/or whitebark pine (Pinus albicaulis) (depending on soil type), spruce, sub-alpine fir (Abies lasiocarpa) and Douglas fir. Above the parkland timber, subalpine fir and whitebark pine are relegated to dwarfed, stunted krummholz forms which ultimately are replaced on more severe sites by frost-churned rocky soil, termed "crust," which supports intermittent colonies of primarily mat-forming subshrubs and forbs. Short grass meadows and shrub stands compose the remaining vegetation structures occasionally found throughout the study area.

Detailed descriptions of vegetation, and habitat types occurring on the study area are described in Harvey (1980), Thompson (1980), Holdorf (1981) and Holdorf et. al. (1980). Much of the area falls within designated wilderness areas which were mapped using landtype associations (USDA Forest Service 1976) rather than the more specific landtypes used on National Forest lands outside classified wilderness.

Fifteen landtype associations (LTA) and 37 landtypes (LT) occur on the study area. Twenty-six percent (12) occur with a frequency of 5% or greater on subsegments of the study area: VI, 202, 182, 71, 25, VIIa, 25C, 18, 181, Vc, VIII, 14D. The following descriptions are summarized from Holdorf et al (1980) and Holdorf (1981). LTA VI describe peaks and alpine ridges which are sparsely vegetated rockland, in a high precipitation zone, with low fuel accumulation and a long recovery time. LT 202 is described as very steep (60%) limestone rockland and scree on fault escarpments or glacial cirque headwalls. Active

gravitational movement of loose rock and soil are common. On most areas active avalanche chutes are common. This landtype normally supports open growing stands of Douglas fir, subalpine fir, spruce and whitebark pine on forested scree. LT 182 is composed of a complex of rock outcrop and talus (75%) and stable soils (25%) on very steep (60%) slopes underlain by limestone. The stable soils are deep, well drained, calcareous soils forming in very gravelly colluvium. Vegetation is principally Douglas fir or limber pine forest on scree. LT 71 occurs on steep (40 to 60%) slopes underlain by interbedded sandstones and shales. The soils are weakly developed acidic forest soils forming mostly in weathered bedrock. Vegetation is lodgepole pine forest on lower slopes grading into mixed lodgepole pine, whitebark pine, and spruce forest on upper slopes. LT25 is described by glacially plastered trough walls (40 to 60% slope) supporting lodgepole pine forest on lower slopes and grading into mixed lodgepole and whitebark pine on upper slopes. Soils are weakly developed forest soils. LTA VIIIa describe very steep (60 to 80% slopes), north facing, forested glacial valley trough walls. Shallow residual soils occur on upper slopes while the lower third of the slope is glacial drift. Avalanche chutes are common. Vegetation is lodgepole pine or mixed spruce and subalpine fir forest in old growth stands. LT 25C is composed of glacially plastered trough walls supporting mixed spruce, alpine fir, and whitebark pine forest. Avalanche chutes are numerous. The weakly developed forest soils have silt loam loess caps averaging 12 to 24 inches. LT 18 is comprised of steep (40 to 60%) west facing slopes, underlain by highly permeable limestone beds. Soils are very weakly developed forest soils forming in calcareous loamy material. LT 181 is described by a complex of stable soils (80%) on rockland and scree (20%) on 60%+ slopes, underlain by non-calcareous rocks. Vegetation is mostly lodgepole pine, whitebark pine, or Douglas fir forest. Forested scree occupies 20% of the landtype. The stable soils are deep, well drained, neutral to slightly acid soils forming in very gravelly or stony colluvial deposits. LTA Vc is broadly described as forested, moderately dissected, residual slopes (25 to 60% slope). More than 50% of the unit is low-order drainage valley side slope. Vegetation is principally lodgepole pine. Soils have developed in parent material consisting of volcanic ash, rich wind deposited silt overlying stony loamy material. LTA VIII is forested, warm aspect breaklands. Very steep (60%+) south or west facing slopes containing 10 to 50% rock outcrop. Vegetation is mixed open growing forest (60%), bunchgrass parks (20%), and dense lodgepole pine forest (20%). Soils are typically deep and loamy, and are often calcareous. LT 14D is composed of moderately steep (25 to 40% slope) landforms formed by slumping north or east slopes, and supporting lodgepole pine or Douglas fir forest with some spruce and subalpine fir. Weakly developed forest soils are moderately well drained, and seeps or springs are common.

The other 35 landtypes and landtype associations which occur on the study area with frequencies of less than 5% are described in Holdorf et al. (1980) and Holdorf (1981) and include: 12, 12A,

17, 20, 20B, 21A, 22, 23A, 24, 25B, 30, 42, 71A, 71B, 72, 160, 161, 170, 171, 172, 177, 183, 200, 201, I, Ib, II, III, IIIa, Va, Vb, Vd, VII, Ve, V. Six percent of the study area which did not occur on forest service land was not landtyped.

METHODS

Trapping and Marking

A 12.2 x 18.3 m (40 x 60 ft) cannon net was used to capture mountain goats at the Blackleaf mineral lick, in the Teton Dupuyer segment of the study area. The site was monitored from July 10 to September 3, 1981, and from June 19 to July 15, 1982. Captured goats were marked with metal ear tags and plastic PVC pipe radio collars, elastic expandable radio collars or color coded canvas neckbands. Frequencies of radio collars ranged from 150.000 to 151.999 MH_z. The sex and age of each animal were determined. If circumstances permitted, measurements were taken on neck girth, body length, shoulder height, chest girth, rostrum length, beard length, ear length and horn lengths and circumferences. The horns of captured goats were usually capped with rubber hose to prevent injury to other goats and goat handlers. Animals were generally blindfolded, which appeared to reduce struggling. Ten to 20 minutes were required to process 1 individual (not including time to untangle goat from net). Several animals "played dead" when released, which seems to be capture behavior common to mountain goats.

Four salt baits were established during 1983 and 1984 in an attempt to capture mountain goats in the Birch-Badger segment during summer 1984. Trap location was predicated on the likelihood of goats discovering the bait, and proper topography to accommodate the cannon net. Salt was dropped by helicopter on a spur ridge about 1 km south of Spotted Eagle Mountain, in the South Fork of Badger Creek. The site was checked from the air and ground throughout the summer, but no sign of goat use was detected. The salt had been heavily used by elk, however, and by August, the 50 pound block was nearly gone. Elk are dominant over mountain goats and will displace them at mineral licks, but whether goats were prevented from using the spot by elk, or the location simply was not proximal to a goat travel route, is not known. A second salt drop at the head of North Fork Birch Creek, about 2 km south of Family Peak, probably would have been used by mountain goats if reconstruction of the trail which passes within 100 m of the site had not kept people working in the vicinity for much of the summer. This well-used trail may have been a problem in trapping regardless of reconstruction crews. The third site was selected on the basis of a likely travel route across the North Fork of Badger Creek, between Running Owl Mountain and Goat Mountain. Intense seismic activity in this area precluded a trapping operation here. The fourth site showed the greatest potential for trapping goats. This site was not discovered until August 1984, when the best period for trapping goats had passed. Substantial traces of goat hair were detected on shrubs along the South Fork of Badger Creek, which led to discovery of a well-used game trail between Curly Bear Mountain and Goat Mountain. A large natural lick exists on the northwest slope of Curly Bear Mountain.

Four cannons are loaded with artillery charges and mounted on metal fence posts at the edge of a mineral lick. Each cannon is attached to the net which is carried over the mountain goats when the charges are detonated (photo by Jim Posewitz).

Capturing mountain goats in the Birch-Badger segment of the study area would be difficult because of high spring run-off, and the remote nature of the country.

Monitoring

Radio-marked goats were generally relocated from a Supercub twice per month from July 1981 to June 1984 and sporadically thereafter, using a Telonics TR-2 receiver/scanner and a rotating 3 element Yagi antenna mounted on the belly of the aircraft. Ground tracking was conducted only when an animal was suspected of being dead, using the receiver and a collapsible hand-held two element Yagi antenna.

Helicopter surveys were conducted over portions of the Rocky Mountain Front during June, July, or August from 1979 to 1986, and winter surveys were conducted in 1979, 1980, 1981, 1982, and April and December 1984. Most surveys were done in a Bell 47 G3B helicopter. Mountain goats were classified as adults, 2-year olds, yearlings, kids and males and females, if possible. Occasionally it was not possible to obtain specific classifications, in which case adults, subadult, kid, nonkid, and unclassified categories were used.

A ground survey was simultaneously conducted by 12 individuals 1 week after the June, 1986, helicopter survey in order to document the efficiency of a ground survey.

Date, drainage, location (Universal Transverse Mercator, UTM), classification and environmental information for each observation or radio relocation were recorded and entered on a computerized observation form (Appendix 4 and 5).

Population Analysis

Mountain goat distribution on the Rocky Mountain Front was analyzed based on 3407 mountain goat records involving 1272 radio-relocations (including 2001 actual goat observations), goats observed during helicopter surveys (1577), other goats observed while radio-tracking (1212), miscellaneous observations (2831), historic kill records (487), and ground survey observations (183).

Home range information including area, geographic activity center (GAC), number of fixes and standard diameter for individual and collective home ranges were calculated using the Telday program (Lonner and Burkhalter 1984) on the Montana State University (MSU) Honeywell computer. Associations between individuals were also calculated using Telday. Population trend information was based on annual surveys and comparisons to historical information. Population estimates were based on a known marked sample of mountain goats occurring in the population and subsequently observing a percentage of that sample during surveys. Radio collars and neckbands on adult animals were used for this purpose but elastic expandable collars fitted on kids, yearlings and 2-year olds could not be observed from the air.

Visibly marked animals were used to calculate an observability rate for adult males (35%), and another rate (82%) for all other goats. A combined average (5 annual surveys) of these rates was applied to the results of annual surveys conducted each July from 1981 through 1985 in the Teton-Dupuyer segment, and from 1982 through 1984 in the Birch-Badger segment, to obtain adjusted annual population levels. A population model was developed using POSIM (Mooney and Lonner 1978).

Habitat Analysis

Categories of environmental information collected for each radio relocation or observation are described in Appendix 5. Vegetation structure and landtype were described previously under Study Area. Terrain types define the physiography of a site. Rock is the primary feature in common with the following 4 terrain types: cliffs and cirque basins - rock faces several meters in height; bluffs - benches with rock drop-offs, often in step-like formation; talus - masses of shale or boulders; broken - areas which are not cliffs, bluffs or talus, but are difficult to traverse due to rocky ground. These types provided maximum security for goats from predators. If an area could not be defined by 1 of the rocky terrain types, then it was classified as 1 of the 4 remaining types including: ridge - the line of land separating two drainages; creekbottom - bottom of a drainage or line of land where opposing sidehills meet; park - a nontimbered flat or sloping area; sidehill - any nonrocky area which would not fit any of the other terrain types.

In 1986 a detailed analysis of the entire study area was undertaken. To establish the relative occurrence of 7 environmental features, a random dot grid was used to generate 2,977 points over 18 1:24,000 USGS topographical maps. Information from analagous aerial infrared photographs, landtype maps, and photointerpretation (PI) maps of timber heights, densities, and stocking rates was gathered for each point. The features measured were topography, elevation, aspect, slope, site type, landtype, and PI type. Topography categories included: ridge, upper slope, mid slope, lower slope, bench/flat, stream bottom. Site types included timber, open timber, shrubs, and open. PI types included: nontimber, poorly stocked, medium-well stocked, unknown (nonclassified wilderness lands). Land types are described in Study Area.

As a whole, the study area is referred to as the Rocky Mountain Front (RMF) (1,298 km^2), and is divided into north, center, and south segments as described in Study Area. In addition to these segments, the study area encompasses 2 hunting districts (HD). The more northerly district, HD415, covers a portion of the north segment, from Glacier National Park south to the North Fork Birch Creek. HD414 extends from the North Fork Birch Creek, south to the Middle Fork Teton and thus encompasses the remainder of the north segment and about two-thirds of the center segment. Six

mountain goat concentration areas occurring north of the Middle Fork Teton River were also defined for habitat sampling purposes. These concentration areas do not define limits of mountain goat occurrence, rather they are sub-samples of areas where goats are consistently observed. The east boundary of the Curly-Family concentration area, for example, does not encompass Mt. Poia, Lookout Ridge or the ridge to Major Steele Backbone, even though goats are often observed in these areas. Three concentration areas occur within each of the north and center segments. UTM coordinates described in Appendix 6, define the extent of each concentration area. Individual and various combinations of areas (study area segments, hunting districts, and concentration areas) were analyzed to determine frequency of occurrence of each environmental feature (Appx 7 through 13). These frequency distributions were then compared between areas with a Chi-square test to assess similarity between areas (Appx 14).

Seasonal Habitat Use

The following describes the basis for development of mountain goat habitat maps which are the foundation of the management guidelines. The variables analyzed for frequency of occurrence in the environment were also summarized from each observation record or radio-relocation record to determine frequency of use. Discriminant analysis using the SPSS (Nie et al. 1975) program was applied to several of these variables to determine which are actually influencing habitat selection by mountain goats. These results, based on 2237 mountain goat records (more than one goat observation may be involved in a record), were used to develop mountain goat habitat maps of the Rocky Mountain Front. The lower boundary of mountain goat habitat generally followed the 1981 m (600 ft) contour because 90% of goat observations occurred at or above this elevation. However the 10% which occurs below 1981 m may constitute critical seasonally important areas (see Seasonal Habitat Selection). Occupied yearlong mountain goat habitat includes both summer and winter seasons. The winter period occurs from October 15 to May 15. Also included in Occupied yearlong habitat are kidding-nursery and breeding areas. The kidding-nursery period extends from May 1 into early fall, but a cut-off date of July 15 is used in the management recommendations. The breeding period extends from November 1 to December 31. Suitable low occupancy habitat met all of the defined environmental criteria for Occupied habitat but mountain goat observations for these areas have not been recorded. Transitional habitat involves those areas through which mountain goats travel, generally during the periods October 15 to December 31 and May 1 to June 30. The areas of Occupied yearlong, Suitable low occupancy, and Transitional mountain goat habitats within the Birch-Badger, Teton-Dupuyer, and Deep-Sun study area segments were calculated using the planimeter option of the GEOSCAN program on the MDFWP Research Lab Discovery computer.

Food Habits

From March through September 1981, efforts were made to observe foraging mountain goats in order to locate 5 feeding sites per month. After hiking to specific sites, a feeding site exam was conducted, which consisted of laying out 15-2X5 dm frames at 2 m intervals along the approximate course which the feeding goat followed, then recording the relative canopy coverage of all vegetation species occurring in the frames.

Plants which were not identified in the field were collected, labeled, pressed and then identified at a later date. All specimens were either verified or identified using Hitchcock and Cronquist (1973) by G. Moore and P. Lesica, botanists, University of Montana. Plants that appeared to have been fed upon at each site were noted. The more obvious species that occurred on the site but did not occur in the sample frames were also noted. Frequency of occurrence and average cover of each species at each site were calculated, then the 5 sites were combined for a monthly total of average frequency and cover.

Five mountain goat pellet group samples were collected per month from March through September 1983, and along with vegetation samples were sent to W. Kasworm for identification of vegetation in fecal samples using microhistological methods (Kasworm 1982).

Human Activities

A base map of the Rocky Mountain Front study area was digitized using the MDFWP Research Lab Discovery computer. Map information for the study area includes political boundaries, 89 drainages, 49 peaks, roads and trails open to some form of motorized transportation, 10 Forest Service cabins, lakes or reservoirs, grazing and outfitter allotments, Forest Service administrative sites, and fire history. Seismic lines since 1980, and mountain goat seasonal habitat were also digitized.

A computer file was created to store mountain goat hunter kill records. Forest Service records were reviewed for information concerning administrative use sites, grazing and outfitter allotments, seismic line locations, timber harvest plans, road distribution, and visitor use days of forest lands.

RESULTS AND DISCUSSION

Population Dynamics

Trapping and Marking

One and 23 mountain goats, respectively, captured at the Our Lake and Blackleaf mineral licks were fitted with radio collars. A brief history of all marked mountain goats is presented in Appendix 15. Body measurement of 11 captured goats are presented in Appendix 16.

Captured mountain goats are blindfolded to reduce excitement and their horns are capped as a safety precaution (photo by Wayne Arnst).

Collective Home Ranges

The yearlong summer and winter collective home ranges for all male and female mountain goats captured at the Blackleaf mineral lick are shown in Figure 2. The collective home range size (Table 1) of both males and females was 305.7 km². Collective summer ranges were larger than winter ranges and collective home ranges of males were larger than those of females. The males' summer and winter ranges were 46.4 percent and 50.6 percent

larger than those of females', respectively. Males reduced their home range size during winter by 26.8 percent while females reduced theirs by 32.6 percent.

Comparing the summer range of each sex to the combined summer range of both sexes, radio-marked males used 90.5 percent of the area while females used only 48.5 percent. Therefore, 9.5 percent of the collective summer range was used by the radio-marked females exclusively while 51.5 percent was used by the radio-marked males exclusively. Comparing the winter range of each sex to the combined winter range of both sexes, males used 97.1 percent of the area while females used only 47.9 percent. Therefore, 2.9 percent of the collective winter range was used exclusively by females while 52.1 percent was used exclusively by males.

The geographic activity centers (GAC) for all of the collective home ranges occurred between the South Fork of Dupuyer and Muddy Creek. The most northerly GAC was the males' summer range in Rival Creek, while the females' winter range was the most southerly in the head of Muddy Creek.

As the standard diameter indicates, two-thirds of all relocations (1135) occurred within 11 km of the yearlong GAC (Table 1). While the standard diameters (SD) of the male summer and winter home ranges were nearly the same, the winter SD of females was slightly larger than the summer SD (Table 1). Either these females tended to use a more linear winter range pattern, or some of their winter movements were larger than summer movements. Approximately 24 percent of the study area, and about 79 percent of the Teton-Dupuyer segment, was used by these 23 mountain goats.

Individual Home Ranges

Individual home range polygons and geographic activity centers for 24 radio-marked mountain goats are shown in Figures 3 through 26. Table 2 indicates the seasonal and yearlong home range size of each radio-marked mountain goat. The data from 7 adult females and 8 adult males were used to make general home range comparisons. At least 46 relocations for each of the 15 goats used to make home range comparisons were obtained over a minimum of 2 years. Summer range maps were based on the period June 15 to September 30, while winter range maps involved relocations from November 1 to April 15. The portion of the yearlong home range not included in the summer and winter maps involves relocations during October and the critical spring green-up period from April 15 to June 15. During spring, mountain goats are in a negative energy balance as they emerge from the rigors of winter, enter the last stages of pregnancy, endure parturition, and begin the strenuous nutritional demand of lactation. So, the area outside of mapped summer and winter ranges, but within the yearlong home range, should also be considered very important mountain goat range.

Table 1. Collective seasonal home ranges of 23 male and female mountain goats along the Rocky Mountain Front.

	Summer (6/15 - 9/30)			Winter (11/1 - 4/15)			Yearlong		
	No. of FIXES	Area (SQ KM)	STD DIAM	No. of FIXES	Area (SQ KM)	STD DIAM	No. of FIXES	Area (SQ KM)	STD DIAM
FEMALES (N = 13*)	254	122.1	7.1	165	82.3	9.1	561	151.9	8.3
MALES (N = 10)	226	227.8	12.3	196	166.7	11.9	574	290.2	12.7
ALL GOATS (N = 23)	480	251.8	10.2	361	171.6	11.1	1135	305.7	11.0

*Includes one male kid.

805/6/27

Table 2. Seasonal home range information for twenty-four radio-marked mountain goats on the Rocky Mountain Front.

	PERIOD COVERED	SUMMER #FIXES	SUMMER AREA	SUMMER SD	WINTER #FIXES	WINTER AREA	WINTER SD	YEARLONG #FIXES	YEARLONG AREA	YEARLONG SD
ADULT FEMALES										
1729	8/79- 7/84	43	30.3	4.3	37	46.3	7.0	110	64.5	6.2
0529	6/79- 9/82	40	25.5	5.3	14	3.4	5.4	66	34.9	6.9
0829	8/79- 7/83	19	35.5	6.3	15	48.6	8.9	53	61.9	6.9
2220	7/80- 7/83	23	6.5	2.6	19	18.0	5.0	55	47.4	4.9
2302	7/82- 1/85	20	10.3	3.3	21	16.3	3.4	56	24.1	3.7
2402	7/82- 1/85	20	11.0	3.5	21	17.0	3.9	56	27.5	3.8
2902	7/82- 5/84	18	11.3	6.4	19	5.6	5.7	46	16.0	6.0
8141	7/81-10/82	19	22.8	6.1	--	---	---	32	24.4	6.4
4922	7/82-10/82	--	---	---	--	---	---	8	13.7	5.8
AVERAGE[1/]		25	19.2	4.7	21	22.2	5.6	53	34.9	5.5
ADULT MALES										
7239	7/79-11/81	26	32.5	12.2	18	28.5	10.9	58	53.5	12.1
1859	7/79- 7/84	48	138.4	10.8	40	94.1	11.8	120	181.5	11.7
2692	6/82- 7/84	22	10.3	4.0	20	10.6	3.6	57	22.9	4.1
1802	6/82- 7/84	19	8.9	4.5	20	54.0	8.7	53	62.6	7.4
6982	6/82- 1/85	19	103.4	10.8	21	41.3	10.3	54	157.5	11.1
8612	6/82- 1/85	20	42.4	10.4	20	29.9	7.8	55	72.8	11.2
3402	6/82- 1/85	19	41.8	5.6	21	64.6	9.4	54	92.1	10.5
7082	6/82- 7/84	19	36.5	6.0	18	39.7	10.1	52	84.7	9.2
7881	7/81-12/84	12	22.2	9.8	6	54.5	13.8	25	76.5	10.9
AVERAGE[1/]		23	48.5	8.2	20	46.4	9.6	59	89.4	9.8
SUBADULTS										
0131	7/81- 8/83	22	34.1	7.9	12	10.0	5.2	45	39.2	7.6
5902	7/82- 7/83	8	9.7	3.8	10	4.3	3.3	26	30.7	6.5
4301	7/81- 9/83	24	26.3	6.7	12	3.4	3.0	46	37.7	5.9
9121	7/81- 7/82	--	---	---	--	---	---	9	10.3	5.2
5261	7/81-10/81	--	---	---	--	---	---	10	21.6	10.2
5302	6/82- 9/83	21	3.5	3.0	10	3.9	2.6	38	13.5	4.1

[1/] Averages are based on adult animals for which at least one year of information is available.

Comparing adult animals for which at least 2 years of information were available, the largest yearlong home range was 181.5 km² for a male while the smallest was 16.0 km² for a female. Only 1 male had a home range smaller than the average for females while all females were smaller than the average for males. The average summer range size for females was slightly smaller than the average winter range, but the reverse was true for males. Average male summer and winter ranges were twice the size of the average female summer and winter ranges, respectively, but the average yearlong home range of males was nearly triple the yearlong range of females. Figures 27 and 28 show the composite yearlong ranges of 9 adult males and 6 adult females. Distribution of the male ranges extends further in all directions

than those of the females, although the south end of Choteau Mountain appears to receive particular use by females. These figures also reveal that the Blackleaf mineral lick forms the most northeasterly point of all female home ranges, which indicates that this mineral lick is an important factor in determining the home range configuration of these 6 females. The males on the other hand, appeared to incidentally incorporate the lick into their ranges.

Mountain goats traditionally use the same areas and travel routes year after year (photo by Jim Posewitz).

Comparing individual summer range size with the respective female and male collective summer home range size, individual female ranges averaged 16 percent of the collective, while individual male ranges averaged 22 percent of the collective summer range. For winter, individual female ranges averaged 27 percent of the collective while individual male ranges averaged 28 percent of the collective. So, while range overlap appears to be similar for males and females during winter, in summer males appear to demonstrate more home range overlap because they expand their summer ranges to a relatively greater degree.

Female mountain goats use a given area more predictably on a year to year basis than do males, based on the average distance between yearly GACs (Joslin 1984). As successive years of information is accumulated, the average distance between GACs of a given female tend to decrease while the average distance between GACs of a male tend to increase, reflecting the male's tendency to explore new country, and the female's conservative nature to use traditional, familiar, and therefore more secure country.

In subadults also, the males tended to have larger home ranges than females. Two GAC's each were calculated for 2 of the subadults. The mean distance between GAC's for the subadult female was double the average for adult females, while that of the subadult male was nearly 3 times the average for adult males (Joslin 1984). This tends to substantiate the fact that, as for other species, both male and female subadult mountain goats are prone to wandering.

Associations

The high degree of range overlap shown in Figures 3 through 26 indicates that mountain goats are not territorial in the classic sense of defending a home range, but they do maintain an individual distance with other goats, depending upon age and sex.

The method of quantifying association is as follows. The distance between mountain goat A and mountain goat B is measured each time a relocation flight is conducted. Goat A and goat B may or may not be related. For example, goat A might be an adult male while goat B might be a yearling female.

The association of any 2 mountain goats is determined by measuring the distances between 2 individuals on a given day and averaging all distances. This provides an index of association which can be compared with any other group of 2 mountain goats. Table 3 describes the groupings as adult female-adult female, adult male-adult female, adult male-adult male, juvenile-all other goats. Twenty-three mountain goats captured from the Blackleaf lick site provide 253 association possibilities. Some transmitters or animals died before other transmitters were put in the field, and only those associations in which a minimum of 4 or more fixes occurred were used, so comparing 2 goats at a time a total of 204 combinations were possible.

Table 3 shows the breakdown of the 204 association possibilities. Most female to female (adult) associations were in the range of 2 to 6 km (75 percent). None occurred at closer than 2 km or over 10 km. The majority of adult males (70 percent) spaced themselves at average distances of greater than 6 km while 30 percent occurred between 2 and 6 km, but none was closer than 2 km. Adult male to adult female spacing was generally between 4 and 10 km (74 percent) but 15 percent occurred between 0 and 4 km while 11 percent occurred at over 10 km. While 71 percent of the juvenile to other goat associations were between 2 and 8 km, 89

percent of all associations in the 0 to 2 km category involved juvenile goats.

Table 3. Percent of mountain goat associations, occurring at various distances from each other, according to sex and age categories.

Association	Number of Pairs	Mean distance in km between any 2 mountain goats					
		0-2	2-4	4-6	6-8	8-10	10+
Female - Female	20	--	50	25	20	5	--
Male - Female	53	2	13	25	30	19	11
Male - Male	30	--	7	23	33	27	10
Juv - Other[2/]	101	8	19	31	21	14	7
Total	204	9	38	57	51	33	16

[1/] Twenty-three marked mountain goats consisting of 7 adult female (30%), 9 adult males (39%), and 7 juveniles (2 years or less) (30%), totalling 204 pairs.
[2/] Juv - other = Juvenile (kid, yearling, or two - year old) to any other goat.

Between certain individuals or groups there does appear to be some association but it is difficult to document an association of choice or chance. Associations between an adult and a juvenile can be presumed to be one of need on the part of the juvenile, and those between females probably reflect the transmission of traditional home range use patterns to offspring. As female offspring mature, they probably adopt at least a portion of their dam's home range. Seventy-five percent of all female to female associations occurred at less than 6 km, while only 30 percent of male to male association occurred at less than 6 km. The fact that 40 percent of male to female associations occurred at less than 6 km may have been a reflection of breeding season, male offspring adoption of a part of the dam's home range, or a combination of both.

The rank of association from most to least closely associated, in general appears to be: females to females, juveniles to other goats, males to females, and males to males.

Population Distribution

Mountain goats are distributed along the entire Rocky Mountain Front. Radio-marked goats have been monitored in the Teton-Dupuyer segment for up to 5 years (2001 relocations), so the data are weighted in favor of this segment. Figure 29 displays 3,407 mountain goat observation and kill records (8,291 individual observations) collected along the Rocky Mountain Front since 1941. These data reflect a general use of Occupied yearlong habitat (see Management Recommendations, Mountain Goat Seasonal Use Areas) in all 3 segments of the study area.

Stability in the Rocky Mountain Front mountain goat population exists because mountain goat habitat is extensive and continuous north of the Sun River to the Badger-Two Medicine Divide (Fig. 30). This habitat continuity facilitates genetic interchange between herds and provides latitude in movement patterns within individual home ranges. Two areas of particular concern exist however. North of Badger Creek, the Mount Pablo-Mount Baldy-Kiyo Crag-Half Dome Crag complex is nearly isolated from the remaining mountain goat habitat along the Front. It is connected by only a thin travel corridor across Badger Creek to Curly Bear Mountain, which is the northern limit of the main mass of continuous mountain goat range on the Front. Similarly, the Goat Mountain - Bruin Peaks - Running Owl Mountain - Bullshoe Mountain complex is isolated from the body of mountain goat habitat except for a narrow travel corridor between Goat Mountain and Curly Bear Mountain. The importance of maintaining the availability of these 2 travel corridors cannot be over-emphasized. Human activities or development which may deter movement along these corridors should be carefully managed. In particular during critical spring and fall movement periods, recurrent helicopter flights could disrupt or prevent movement of goats along these travel routes.

Other natural, but less distinct breaks in mountain goat habitat along the Rocky Mountain Front seem to occur along the South Fork of Birch Creek, the North and West Forks of the Teton, the Middle Fork of the Teton, and Blacktail Gulch. These natural delineations result in 4 relatively autonomous mountain goat population segments involving: (1) Birch and Badger creeks including the Goat-Bullshoe, Curly Bear-Family, and Field-Drewyer concentration areas, as well as Lookout Ridge-Major Steele Backbone area and the Kiyo-Half Dome areas; (2) North Fork Teton and Dupuyer creeks including the Walling-Old Man, Patrick Gass-Teton Peak, and Frazier-Choteau concentration areas; (3) the head of the South Fork Teton and Sun River side of the Sun River-Deep Creek Divide, involving Old Baldy, Rocky Mountain and south to Arsenic Mountain; and (4) south of the South Fork Teton to the Sun River at Diversion Lake including Ear Mountain, Chute Mountain, Deep Creeks, and Castle Reef. More discrete population segments may exist in the Deep Creek-Sun River country, but recent information is lacking to define them.

The pattern of mountain goat distribution along the Rocky Mountain Front appears to have changed somewhat over the past 35 years. Compared to distribution of 3 decades ago (Fig. 31), current distribution appears to have shifted to the north, but a portion of this difference is simply an aritfact of research intensity. Casebeer et al. (1950) did not extend their field reconnaissance trips into the Birch-Badger area, and thus they did not record significant goat use. Mountain goats have probably always inhabited this area. On the other hand, the shrinkage in distribution of mountain goats in the Deep-Sun segment is real. Mountain goat inventories in this area,

conducted regularly since the 1960s, have shown reduced distribution throughout this segment, the possible causes of which are discussed in Historical Perspective. Although climatic factors have been suggested as a possible cause of shrinking distribution, snow survey records extending back to 1937 indicate that the gradient in snow pack along the Front, from light in the south to moderate in the center to heavy in the north, has been consistent over the years. It is possible that because the south segment receives less moisture than the rest of the Front, that mountain goat recovery in this area may be slower than it would be in an area receiving greater precipitation, and thus presumably producing a greater quantity or higher quality forage.

The primary threat to a change in current population distribution is in the north segment where the 2 previously described habitat islands may be severed from effective use by goats because of energy exploration activity crossing existing mountain goat travel corridors. Areas of low mountain goat density, where populations are far below potential, include most of the Deep-Sun segment, the Mount Pablo to Half Dome Crag island habitat, and the Elk Calf Mountain to Running Owl Mountain area. Increased mountain goat populations in these areas are contingent upon minimizing population depressants, primarily seismic exploration and exploratory drilling activities and hunting. The effects of these activities can be minimized through strict application and adherence to the mountain goat section of the Rocky Mountain Front Interagency guidelines (1984) (Appendix 17). The issue of hunting in the Deep-Sun segment is moot since a sanctioned hunting season does not exist in this area. Although the Mount Pablo to Half Dome Crag complex occurs within hunting district 415, the primary hunting mortality in this complex may be illegal. A change in hunting district boundary may be advisable to provide additional protection to this area.

Population Estimates and Trends

Although information has been collected on the Rocky Mountain Front mountain goat population since 1978, the helicopter surveys conducted in July 1979 and August 1980 can not be compared to the surveys done after 1980, since the same areas were not covered, classification schemes differed, and observers changed. Since 1981, these variables have remained constant. Data collected since 1981 is used in establishing population estimates and recent trends. In-depth analysis of population trends in the Birch-Badger and Teton-Dupuyer segments, and possible causes of population variability, is presented in Joslin (1986) (Appendix 18). Results of an extensive ground survey conducted in June 1986, are presented in Appendices 19, 20 and 21.

Birch-Badger Segment

All or part of the Birch-Badger segment of the mountain goat study area has been intensively surveyed by helicopter seven times in the past 6 years (Table 4, Appendicies 22 through 39). Four spot checks have been conducted since 1979. The information tends to show a fluctuating population.

Table 4. Summer helicopter surveys of mountain goats in the Birch-Badger segment, 1982-1986.

Adjusted Survey

Year	Total	AD M/F	SA	Kid	K:100NK	K:100AD	K:100ADF
1982	119	43/40	10	26	28.0	31.3	65.0
1983	112	26/42	20	24	27.3	35.3	57.0
1984	85	29/40	11	5	6.3	7.2	12.5

Actual Survey

1982	77	15/33	8	21	37.5	43.8	63.6
1983	80	9/35	16	20	33.3	45.4	57.1
1984	56	10/33	9	4	7.7	9.3	12.1
1986	72	21/28	12	11	18.0	22.4	39.3

*Adjusted survey based on 82% observability of adult females, subadults, and kids, and 35% observability of adult males.

Table 5. Square kilometers of seasonal mountain goat habitat along the Rocky Mountain Front, north of the Sun River to Glacier National Park.

	BIRCH - BADGER SEGMENT	TETON - DUPUYER SEGMENT	DEEP - SUN SEGMENT	TOTAL
Occupied Yearlong (1)	238.95 (45.1%)	279.73 (72.6%)	260.80 (68.3%)	779.48 (60%)
Suitable Low Occupancy (2)	39.55 (7.4%)	----	12.0 (3.1%)	51.55 (4%)
Transitional (3)	251.81 (47.5%)	105.81 (27.4%)	109.35 (28.6%)	466.97 (36%)
Total Area	530.31 (40.86%)	385.54 (29.70%)	382.15 (29.44%)	1298.00 (100%)

Using the observability rate calculated for marked goats from the Teton-Dupuyer segment (Table 6), and land area measurements of mountain goat habitat within each segment of the study area (Table 5), the population estimate ranges from 85 to 119 mountain goats, or a density of 1 goat per 2.9 km^2, to 1 goat per 2.1 km^2 (or roughly 1 goat per mi^2) in Occupied habitat.

Teton-Dupuyer Segment

The Teton-Dupuyer segment has been surveyed 12 times since 1979 (Table 7, Appendicies 22 through 39), although only the flights since 1981 were compared, when similar flight paths, observer, pilot, and classification scheme were used. The July 1984, 1985, and June 1986 flights differed from previous surveys in that the area south of the Middle Fork Teton was not covered. These flights however, do supply the most reliable figures from which to calculate a population estimate and density, in that mountain goats captured and marked at the Blackleaf lick tended to confine their movements to the area north of the Teton, and thus a Lincoln-Peterson index is most appropriately applied to just this area. When the other surveys since 1981 are modified so that comparison of data from the Middle Fork Teton to North Fork Dupuyer are made, then population estimates range from 53 to 113 mountain goats, or a density of 1 goat per 5.3 km^2 to 1 goat per 2.5 km^2 (or roughly 1 goat per 1-2 mi^2) in Occupied habitat. The overall population trend in this segment has been down.

Table 6. Observability rate of marked mountain goats, 1981-1985.

YEAR	FEMALES	OBSERVED	%OBSERVED	MALES	OBSERVED	%OBSERVED
1981	3	2	66.6	3	0	0.0
1982	7	6	85.7	11	4	36.3
1983	7	5	71.4	8	1	12.5
1984	7	7	100.0	10	5	50.0
1985	4	3	75.0	8	4	50.0
TOTAL	28	23	82.1	40	14	35.0

Table 7. Summer helicopter surveys of mountain goats in the Teton-Dupuyer segment, 1981-1986.

Year	Total	AD M/F	SA	Kid	K:100NK	K:100AD	K:100ADF
Adjusted Survey							
1981	113	37/40	21	15	15.3	19.5	37.5
1982	99	46/30	12	11	12.3	14.5	36.6
1983	74	37/27	6	4	5.7	6.3	14.8
1984	95	43/34	11	7	8.0	9.1	20.6
1985	65	34/22	4	5	8.3	8.9	22.7
1986	53	26/18	7	2	3.8	4.8	11.1
Actual Survey							
1981	75	13/33	17	12	19.0	26.1	36.3
1982	60	16/25	10	9	17.6	22.0	36.0
1983	43	13/22	5	3	7.5	8.6	13.6
1984	58	15/28	9	6	11.5	14.0	21.4
1985	37	12/18	3	4	12.1	13.3	22.0
1986	32	9/15	6	2	6.7	8.3	13.3

*Adjusted survey based on 82% observability of adult females, subadults, and kids; and 35% observability of adult males.

Deep-Sun Segment

The Deep-Sun segment has been intensively surveyed 4 times between 1981 and 1983 (Table 8, Appendicies 22 through 39). Spot checks have been flown on 4 occasions since 1979. In 1984, project emphasis shifted to the Birch-Badger segment, which is why recent information has not been collected from this area. Mountain goats have not been marked in this segment, and available information is so limited that even an indication of trend is not possible.

Adjusting the results of the July 1982 survey (which produced the highest survey results) according to average observability rates calculated for the Teton-Dupuyer segment, a population of 51 mountain goats is estimated. Based on this estimate, mountain goat density in Occupied habitat in the Deep-Sun segment is 1 goat per 5.1 km^2, or only about 39% of the high and similar to the low density estimate of the Teton-Dupuyer segment. All indications are that the population level of the Deep-Sun segment is very low.

Based on a relative lack of seismic activity and roads (see Human Activities), this area should be supporting a healthy mountain goat population. However, intense hunting and trapping (for transplant stock) pressure from the late 1940's to 1970 resulted in a significantly reduced population. In addition, impacts from

livestock grazing may have also been involved in the herd declines. This depressed condition remains today and may be aggravated by livestock (cattle and pack stock) grazing on Forest Service lands which overlaps with about 28 percent of the Occupied habitat in the Deep-Sun segment. Approximately 6 percent of Occupied habitat in the Deep-Sun segment occurs on BLM lands that also supports livestock grazing.

Table 8. Helicopter surveys of mountain goats in the Deep - Sun segment, 1979-1983.

Survey Date	Area Covered	Total	M	F	AD	2	Y	SA	K	Un
7/79	Deep-Sun spot	7								7
11/79	Deep-Sun spot	12								12
3/80	Deep only	0							4	9
8/80	Deep only	13								
3/81	Deep-Sun entire	20			14			2	3	1
7/81	Deep-Sun entire	2		1					1	
4/82	Deep-Sun spot	11			4			3	4	
7/82	Deep-Sun entire	35	5	8	8			9	5	
7/83	Deep-Sun entire	27	1	10	6		2	4	4	

Mortality and Projected Population

Six collared mountain goats including 4 radio-marked and 2 neckbanded animals are known to have died over the course of the study. A 3-year-old male and a 3-year-old female were taken during the hunting season. A yearling male and 6+-year-old female apparently were killed in avalanches. A 10-year-old male and 5-year-old female either died of natural causes or were illegally shot. The collar, hair and bone fragments of the 10-year-old male were found near the Cave Mountain campground. The collar and carcass of the 5-year-old female were located within 200 m of a well-used recreational trail which crosses the Blackleaf lick. The proximity of both carcasses to areas heavily used by people supports the possibility of poaching.

Reproductive histories of from 1 to 6 years were documented for 11 marked adult females (at least 3 years old) (Table 9). Assuming 1 kid born per female per year, potentially 38 young could have been born to these females over the course of the study. Eighteen kids were born, but 6 of these died. Twelve were recruited to yearlings while the fates of 4 others were undetermined. Sixty percent of the kids that died did so between July and September. Productivity ranged from a maximum of 100% (N=3) in 1979 to 0 (N=5) in 1984. Recruitment was highest prior to initiation of this study (Thompson 1980) and dropped to 0 by 1983-84.

Table 9. Reproductive history of 13 female mountain goats.

ID.#	AGE	1979	1980	1981	1982	1983	1984	1985	1986
1172	4 yrs	K→	Y_K→	Y_K-died	K-died	0	0	Trans.[1]	
1082	4 yrs	K→	$Y_?$	?	?	0Trans.			
1052	3 yrs	K-died	K→	Y_K-died	K-Trans.				
1222	3 yrs		K→	Y_K→	Y_K→	$Y_{Trans.}$			
1290	AD				K-died	K	(early '84) Dead		
1230	AD				K→	Y_0	0	0	0
1240	2 yrs.				----	0	0	0	0
1814	4 yrs.				Dead (late '82) K-died	K (590M)			
430	1 yr.			430	551	Trans.			
492	3 yrs.					0			
912	1 yr.			Trans.[2]					
32	AD				0	0	0	K	
42	5 yrs.				0	0	0	0	0

[1] Trans. = transmitter failed; [2] Transmitter retrieved by seismic crew. No sign of goat.

Kid mortality has been estimated to range from 15 to 80 percent (Hibbs 1966, Holroyd 1967, Rideout 1978, Stevens and Driver 1978). Yearling mortality estimates range from 2 to 59 percent (Holroyd 1967, Rideout 1974, Chadwick 1977). Adams and Bailey (1982) used 6 percent mortality in adults to simulate population growth, while Chadwick (1977) estimated 10 to 12%, and Youds et al. (1980) used 7% adult mortality in simulations. During this study, 3 years of survey information from the Teton-Dupuyer and Birch-Badger segments combined, yielded an average natural mortiality of 51% for kids, 39.0% for yearlings, 5.5% for 2 year olds, and 5.2% for adults. Hunting accounted for an estimated additional 3.1% mortality in adults (4 to 5 per year) and 10.4% (1 goat) in yearlings. The longevity of this population was estimated based on the 1984 population of 180, an equal sex ratio, and an average birth rate of 37%. Within 25 years, it is predicted that this population will have declined by about 74% to 47 goats, and recruitment of yearlings and 2-year-olds will have declined to 0. Even with hunting mortality removed from the analysis, the population continues to decline, but at a slower

rate. The decline appears to be more rapid in the Teton-Dupuyer segment than in the Birch-Badger segment. This difference may be the result of more road access, higher hunting permit allocations, and a greater harvest of females in the Teton-Dupuyer than in the Birch-Badger segment (Joslin 1986b).

Historical Perspective

The Rocky Mountain Front mountain goat herd probably has the longest recorded history of any population in Montana. From 1919 to 1942, mountain goat numbers were estimated in Forest Service reports, and in 1943 the MDFG began making population estimates according to management units. The most valuable information from these historical reports were actual sightings of mountain goats. Population estimates varied tremendously as those who prepared the reports changed.

The MDFG (Casebeer et al. 1950) attempted to estimate the population of the entire Northern Continental Divide mountain goat herd, which extends north from Highway 200 to Glacier National Park and east from the Flathead valley to the foothills bordering the Rocky Mountain Front. Although most goat ranges were visited on foot, this entire area was covered in 1 season by 2 observers which necessitated a rigorous schedule. Estimates of mountain goat numbers in each area were given, whether or not goats were actually observed. From 337 mountain goat observations, a population estimates of 1,990 was calculated. While the usefulness of this information is limited, the general localities where goats were observed is useful. Other reports providing information include Howard and McNeal (1936), Cooney (1942, 1946), Brandborg (1950), McLucas et al (1948), Rognrud (1983), and MDFG job progress reports. Mountain goat distribution along the Rocky Mountain Front, pieced together from these reports, does not seem to have appreciably changed over the past 30 to 50 years, although relative abundance does appear to be reduced in many cases, particularly in the Deep-Sun segment.

Birch-Badger Segment

Casebeer et al (1950) estimated the population for Elk Calf-Big Lodge Mountain (65), Bowl Mountain-Muskrat Pass(80), Mount Drewyer (10), Mount Richmond (10), Scarface Mountain (10), Spotted Eagle Mountain (10), and Goat Mountain (15). The first 2 areas were included in the Middle Fork Flathead estimate, but these areas extend along the Continental Divide between the Middle Fork Flathead and Badger Creek, and the Middle Fork and Birch Creek, respectively, so they are included here for an estimated total of 200. While this estimate appears to be comparatively high (a maximum of 80 goats were observed in systematic surveys during the present investigation), except for the Elk Calf-Running Crane area, relative occurrence is similar. During routine annual big game estimates made by the MDFG, from 6 to 20 mountain goats were estimated to occur on the Blackfeet Indian Reservation. Specific locations of where on the Reservation goats occurred are not given, but Heart Butte, and

From 1941 to 1957, 110 mountain goats were trapped on the Deep Creek plateau for transplant stock to other areas. The goats were packed off the plateau in wooden crates on horse back (MDFG photo).

Major Steele Backbone are likely habitat and are identified as Suitable habitat on current distribution maps (Figure 30).

Other mountain goat observations in this area are provided by the Forest Service in Howard and McNeal (1936). They noted: 14 goats in lower Birch and Sheep creeks on March 20, 1936; 20 goats had been regularly seen on the high ridges between South Fork Birch Creek and Walling Reef in 1935 and in preceding years by Forest Service employee and resident of Birch Creek Dam, E. F. Chenault; 1 billie was repeatedly observed by the lookout on Half Dome Crag. "Wild mountain goats have been known to mix with a band of permitted domestic sheep on the North Badger Range on areas along the Continental Divide for a few days during the mid-summer... Nearly every summer during June or July, a number of goats are seen by employees on Goat Mountain above the North Badger trail... Goat signs are usually plentiful during the summer months on Curly Bear and Spotted Eagle Mountains". Howard and McNeal (1936) explain that goats do not migrate, but do travel about in winter by way of mountain ridges from low ends of reefs across rocky gorges, for example, going from Phillips Creek

across Sheep Creek to Walling Reef to Bennie Hill, and from lower North Fork Deep to lower South Fork Deep across the gorges. Thirty-one goats were observed doing this in March 1935.

In reference to possible range conflicts, Howard and McNeal (1936) indicate that "The use of domestic stock during summer season on many areas limits the use by game of much of those areas in winter. Particular reference to ranges inside the Forest is: Middle and South Fork Birch Creek and both forks of Sheep Creek, these are heavily grazed by permitted stock in summer. The Birch Creek ranges are good year-round elk and deer ranges; the same applies to both forks of Sheep Creek and in addition are needed for the increasing goat numbers in that locality". Twenty-five grounds are regularly salted in the Birch Creek grazing allotment (Howard and McNeal 1936).

Teton-Duypuyer Segment

The 1950 population estimate for the Teton-Dupuyer segment (Casebeer et al 1950) was calculated based on the following areas: Mount Wright (10), Blackleaf Creek (10), Choteau Mountain (15), Old Baldy (10), and Rocky Mountain (43), for a total estimate of 88. While this total for the entire segment is reasonable, the estimate for Rocky Mountain was comparatively high, while other areas such as Muddy Creek, Walling Reef, heads of Dupuyer Creek-North Fork Teton, Mount Lockhart-Teton Peak, and Cave Mountain were omitted. The maximum number of mountain goats observed during intensive helicopter surveys from 1981 to 1985 was 89.

Howard and McNeal (1936) report the following observations during 1934 through 1936: 2 mountain goats in Canyon Creek-North Fork Dupuyer in June, 13 in Rierdon Gulch in May, 20 in Nanny Creek in June, 28 on Mount Wright in June, 52 in 1 band at the head of the South Fork Teton in June, 1 repeated observation of a billy on Volcano Reef, 2 in the pass between Blackleaf and the East Fork North Fork Teton. They report "goats as plentiful on high peaks and ridges in the Blackleaf to Ear Mountain areas". Based on his 13 years experience with the Forest Service, Ranger McNeal speculated that the mountain goat population of the Teton Unit (Forest Service terminology for the area north of and including the South Fork Teton to Glacier National Park) had doubled within the 10 year period from 1926 to 1936. He felt that goats were ranging over a much wider area than in former years.

Deep-Sun Segment

This segment has more colorful history and controversy associated with it than the other 2 segments. Although Casebeer et al (1950) gives population estimates only for Castle Reef (18) and the South Fork Deep Creek (52), they describe mountain goat distribution as being extensive throughout this segment. The area from Beartop Lookout east to Ear Mountain, then from this

imaginary line south to Arsenic Mountain and Castle Reef (near the mouth of Hannon Gulch), describe a solid mass of mountain goat occurrence (Fig. 31). The Sheep Reef area was separated from the main area of goat distribution near Arsenic Peak, by about 1 km. Much of the currently described Occupied habitat in this segment is based on some 400 reports of hunter killed mountain goats from 1955 to 1970 in this segment. The maximum number of mountain goats observed in this entire segment during recent systematic helicopter surveys was 35 in 1982, but none of these observations occurred in the southwest one-third of the segment from Hannon Gulch to Biggs Creek, where some 75 observation records are listed from past years. The largest group of mountain goats observed during the 1980's study was 15 in the Headquarters Pass area (Appendix 23 & 33); whereas a group of 25 goats was observed within 0.5 km (0.3 mi) of a cattle salt ground between the South Fork Teton and Deep Creek in June 1947 (Brandborg 1950); and McLucas et al (1948) reports 12 at the head of Sheep Gulch in June 1948, 26 on the east slopes of Rierdon and upper Slim Gulch in July 1948, and 27 on the North Fork Deep Creek in June 1948. Howard and McNeal (1936) related an observation by dude rancher Ken Gleason of 20 mountain goats in 1 band on the rocky ridge southwest of Ear Mountain.

When Goers and Brandborg (McLucas et al. 1948) conducted a horseback survey in August, 1948, they reported 115 mountain goats in the Deep Creek-South Fork Teton area. Their survey was a follow-up to the trapping and transplanting program which had been underway at the North Fork Deep Creek mineral lick since 1941. From their survey, they recommended trapping not more than 15 goats per year, and indicated that this level of removal would not have an adverse effect on the population. "Migration and movement from adjacent ranges apparently offsets the effects of removal from the Deep Creek trapping site."

The mountain goat trap on the North Fork Deep Creek had been established in 1941 on a livestock salt grounds as part of the newly implemented General Wildlife Restocking Project (Rognrud 1983). In the 17 year period from 1941 to 1957, 110 mountain goats were trapped on Deep Creek and transplanted to Colorado and 8 locations within Montana (Crazy Mountains, Beartooth Mountains, Gates of the Mountains, Elkhorn Mountains, Square Butte, Spanish Peaks, Ennis Dam, Benchmark). Over one-third (35.4 percent) of all mountain goats transplanted within Montana came from Deep Creek.

When in 1967 a helicopter survey produced unsatisfactory observation results, it was concluded that "Limited access combined with conservative hunting regulations have undoubtedly contributed to the low production ratios obtained in Hunting District (HD) 414. To prevent population stagnation, and increase production within the district, hunting seasons should be lengthened and quotas liberalized" (MDFG 1968). At this time, HD 414 included the Deep-Sun segment. The season ran from

September 15 to November 26 with a quota of 80 permits, so the season was lengthened to December 15 and the quota increased to 100. The information which prompted this change was a kid:adult ratio of 23 per 100 from a total of 23 observed goats. In the Crazy Mountains and on Square Butte, ratios of 42 per 100 and 62 per 100 respectively, were being observed at this time, but these were both introduced herds. Current knowledge of mountain goat population dynamics indicate that a ratio of 23 per 100 is moderate to low for native herds. In light of the recently recognized phenomena of reduced productivity which seems to occur in depressed mountain goat populations (Hebert and Turnbull 1977, Joslin 1986b), hunting should have been halted, or at least significantly reduced rather than increased. From 1960 to 1970, 70 mountain goats were harvested from Deep Creek and 22 were taken from Ear Mountain. By 1975, Erickson et al. (1975) recommended closing the hunting season and advised that no further trapping for transplant purposes be done, based on a survey in which no goats were observed from Headquarters Pass to Gibson Dam.

In summary, mountain goat distribution appears to have diminished from pre 1950's levels along the Rocky Mountain Front in the following areas: Elk Calf to Running Owl Mountain, Lookout Ridge to Major Steele Backbone, and the entire southwestern one-third of the Deep-Sun segment from Beartop Lookout to Hannan Gulch. Inadequate information exists in the Birch-Badger and Teton-Dupuyer segments to make comparisons of existing and past population levels, but from the general tone of old reports, it seems to be similar. In the Deep-Sun segment, the population is below pre 1950 levels.

Habitat Analysis

Physiography of the Study Area

Detailed environmental information for each segment, hunting district, and concentration area of the study area is presented in frequency distribution tables in Appendicies 6 through 13. General descriptions of areas follow.

Study Area Segments The north segment is relatively lower in elevation ($\bar{x}$ = 1937 m), has gentler slopes ($\bar{x}$ = 49.2%), and more northerly aspects than the center or south segments. The center segment is intermediate in elevation between the north and south segments ($\bar{x}$ = 2030 m), has the steepest slopes ($\bar{x}$ = 53%), and primarily east, west, and southeast and northeast aspects. The south segment has the greatest elevational range ($\bar{x}$ - 2085 m), intermediate slopes compared to the north and south segments and is characterized by westerly aspects. Although the south segment has the largest proportion of timber and open timber site types (69% compared to 63.7% and 65.4% in the north and south), it has the lowest quality commercial timber values with 27.9% of the area occurring in the medium to well stocked category (35.9% in north, and 33.3% in south). The most abundant land type in all 3 segments was VI, followed by 202 in the center and south and 182

in the north. The center segment shows the most variety in land types (32), but only 5 of these occur with a frequency of 5% or greater. On the other hand, the north and south segments have fewer lands types (27 and 26, respectively), but both segments have 7 land types with frequencies of 5% or greater.

Concentration Areas The six measured concentration areas have an average elevation of 2974 m, mean slope of 57%, a paucity of northwest, south, and flat exposures, and more open that timbered terrain. Either land type 202 or VI is dominant in all but one area (LT 182 in area E); and between the 6 areas, 27 land types are represented, but only 11 occur with frequencies of 5% or greater. Concentration area A (Goat Mtn - Bullshoe) has the most variety in land types with 7 occurring with a frequency of 5% or greater, while concentration area C (Mt Field - Drewyer) only has 2, with a frequency of at least 5%. The highest concentration area ($\bar{x}$ - 2184 m) is E (Patrick Gass-Teton Pk.), while areas B (Curly Bear-Family), C (Mt. Field-Drewyer), and D (Walling-Old Man) all average about 2020 m. The northern 3 concentration areas tend to be a bit lower in elevation ($\bar{x}$ = 2030 m), about the same in slope ($\bar{x}$ = 57.4%), dominated by northeast and east aspects, and have slightly more quality commercial timber (medium to well stocked) than the center 3 concentration areas (elevation $\bar{x}$ = 2110 m, slope $\bar{x}$ = 56.6%). The northern concentration areas tend to be higher in elevation, steeper, and less timbered than the north segment as a whole. The same is true for the center 3 concentration areas compared to the center segment as a whole.

Hunting Districts A comparison of HD415 with HD414 is actually a comparison of concentration areas A and B with concentration areas C, D, E, and F. Little apparent difference exists between the 2 hunting districts, although HD414 is slightly higher ($\bar{x}$ = 2085 m) and has less available quality commercial timber than does HD415 ($\bar{x}$ = 2034 m).

While a qualitative analysis of differences between areas (based on the frequency distribution of environmental features) reflect only broad distinctions, statistical analysis of these features results in technically significant differences between many of the areas.

Five environmental features were statistically compared (Chi-square test) between the various areas defined along the Rocky Mountain Front, to determine to what extent the areas differed, and thus whether differences in mountain goat herd segments might be explained on the basis of environmental differences. The environmental features which appear to be most important in describing differences between individual areas are, in order of importance: topography, slope, site type, aspect, and elevation. Differences in elevation, aspect, slope, and site type are self-explanatory. A brief discussion of topographical differences follows.

Relative abundance of the topography categories reflect the distribution and shape of mountains and valleys. The broader the

valleys and thus the farther the mountains are apart, the more lower slope, creekbottom, and flat topography categories occur. All 3 study area segments differed significantly in topography. The north segment has broad valleys compared to the other 2 segments. The configuration of the south segment is long, parallel ridges with U-shaped drainages, as compared to the center, which has a more disorganized pattern of individual mountains and drainages running in numerous directions.

Chi-square analysis of the north, center, and south segments (Table 14) indicated significant differences in 3 to 5 of the 5 environmental features. The north segment was highly statistically different ($p < .0001$) from either the center or south segments in all 5 features. The center and south segments were similar in slope and site type, but varied in topography ($p < .05$), elevation ($p < .001$), and aspect ($p < .001$).

A comparison of north and center concentration areas also shows significant differences in all 5 features. Comparisons of individual areas reveal that area B and E differed the most with 5 features being highly significantly different ($p < .005$). Areas differing in 4 features were A and D, A and E, B and D, and B and F. Areas differing significantly in 3 features were A and F, B and C, C and D, C and E, and D and E. Areas differing the least, with 2 or fewer differing features were A and B, A and C, C and F, D and F, and E and F. Area F (Frazier-Choteau) was most similar to the other areas in that it differed from only 2 of the 5 other areas in 3 or more environmental features, while areas B, D, and E differed the most from the other areas. Each of these areas differed from 4 of the other 5 areas in 3 or more environmental features.

How, and to what extent mountain goats use each of these concentration areas is not fully understood. All 6 concentration areas are known kidding-nursery areas, breeding areas, and yearlong range.

Since all concentration areas are probably used by goats yearlong the indicated differences between these areas appears not to be as relevant to mountain goats as the statistical analysis infers.

Although this analysis was conducted to determine whether environmental features may influence the population of each area, a correlation between environmental features and population trend is not clear. The goat population in the center segment appears to be consistently declining while that of the north is vascillating.These segments greatly differed ($p < .0001$) in all 5 environmental features. On the other hand, the center and south segments are environmentally more similar that either the center and north or the south and north. Population density of the center segment is approaching that of the long depressed southern segment.

Environmental features alone cannot explain differences in population levels between study area segments. The center and south areas, which are physiographically most similar, appear to have somewhat similar population densities at the lower range of estimates for the center segment. At the same time, the north and center areas, which are physiographically different, have similar population densities at the high end of the population estimate for the center segment.

Seasonal Habitat Selection

Analysis of seasonal habitat selection was based on a total of 8291 mountain goat observations. Complete environmental information for each record could not always be obtained. Landtypes, terrain types and vegetation types were more frequently determined for each record than aspect, elevation and slope since the latter require precise locations, while the former cover general areas.

In order to obtain an indication of mountain goat preference of various environmental features, availability of each was determined. A frequency analysis of 5 environmental variables was determined on 1463 random points distributed over a sample portion of the study area (Appendix 40). Similar frequency analysis were completed on 153, 266 and 2237 records of mountain goat observations during the kidding-nursery period (Appendix 41), breeding period (Appendix 42) and the combined summer and winter periods (yearlong habitat) (Appendix 43), respectively. The 5 variables included slope, elevation, aspect, distance to nearest driveable road, and landtype.

Discriminant analysis was performed on the first 4 variables to determine which are important to mountain goats in selecting seasonal and yearlong habitat. For all 3 tests (kidding-nursery, breeding and yearlong) the most important variable was slope followed by elevation. The third most important variable in selection of kidding-nursery and yearlong habitat was distance to the nearest driveable road, while aspect was the third variable in selection of breeding habitat.

Slopes greater than 70 percent account for less than 20 percent of the available habitat (Appendix 40), but more than 75 percent of the mountain goat observations during all 3 seasonal periods (Appendix 41, 42, 43) occurred on slopes of 70 percent or greater. Elevations over 2134 m (7000 ft) account for less than 35 percent of the available habitat but 75, 83 and 75 percent of the kidding-nursery, breeding, and yearlong mountain goat observation records, respectively, occurred at elevations of 2134 m and above. Aspects between northeast and southeast account for about 42 percent of the available habitat but 59, 65, and 59 percent of the kidding-nursery, breeding, and yearlong mountain goat observation records, respectively. About 77 percent of the sampled area occurred at distances of over 1.6 km (1 mi) from a

road while at least 93 percent of the mountain goat observations during all 3 seasonal periods occurred at distances of over 1.6 km.

In a bi-level analysis of habitat selection by mountain goats in coastal Alaska, Smith (1986) indicates that because mountain goats select habitat at more than 1 level, an evaluation of availability versus use of various habitat parameters, at the broadest level of habitat selection (ridge-and-valley complex), can be misleading. Although preference/avoidance tendencies appear at the first level of habitat selection (establishment of home range), the second level of selection (preferred and avoided habitats within the animal's home range) is critical to understanding the importance of various habitat parameters to mountain goats.

Mountain goats select habitat to meet security, nutritional, and thermo-regulatory needs (photo by Jim Posewitz).

For example, it is quite possible that although 90% of yearlong mountain goat use along the RMF occurs at elevations at or above 1829 m (6000 ft). The 10% which occurs below 1829 m is a vitally important portion within the home range. Limited records were available during the kidding-nursery period (153), but 11% of these occurred at elevations below 1829 m. Smith (1986) found this to be the case in Alaska. Although goats generally avoided lower elevation areas in the course of their annual movements, the low elevation areas which did occur within a goat's home range was often used, or even preferred, during winter. Similarly, although most goats appeared to avoid commercial forest in establishing their home range, within the home range, old growth forest was not avoided and was in fact preferred by 31% of the females and 43% of the males.

A similar bi-level analysis of mountain goat habitat along the RMF may reveal similar discrepancies in the perception of what constitutes mountain goat habitat. Habitat information from the RMF indicates that the generalization that mountain goat habitat is confined to barren ground peaks is erroneous. In fact, the lower boundary (1829 m) of delineated mountain goat habitat, below which at least 10% of the mountain goat observations occur, may constitute some of the more critical habitats for mountain goats within their home ranges along the Rocky Mountain Front.

Seasonal Distribution

Over 8290 observations of mountain goats were used to develop seasonal range use maps (Figures 32 through 50). Within the study area, all country above 1829 m (6000 ft) occurring on slopes of 70 percent or greater are classified as Occupied (number 1 on maps) or Suitable (number 2 on maps) use areas based on habitat selection data described previously. There is little definable difference between summer and winter habitat selection, so these seasons were combined. Known kidding-nursery areas are identified with a dotted line in Figures 32 through 50. Kidding-nursery areas are noted on the map if a solitary female was observed during May or June or if a group of goats which contained a kid was observed during June, July or August. Known breeding areas are identified with a dashed line in Figures 32 through 50. All observations of adult ($2\frac{1}{2}$ years-of-age and older) males and females during November and December were used to delineate breeding areas. Areas known to have been used during both kidding-nursery and breeding periods are identified with an alternate dash-dot line in Figures 32 through 50.

Table 5 displays km^2 of Occupied, Suitable, and Transitional mountain goat habitat within each study area segment along the Rocky Mountain Front. The Birch-Badger, Teton-Dupuyer, and Deep-Sun segments comprise 40,30, and 30 percent of the study area, respectively. Although Birch-Badger is the largest segment, mountain goat habitat in this area is more dispersed so Transitional habitat covers more area than in the other 2

segments. Relative to total size, the Teton-Dupuyer segment contains the largest percentage of Occupied habitat. The absence of Suitable habitat (number 2 on maps) in this segment, can be attributed to intense study within this area rather than a supposed lack of goat use, as is indicated in the other segments where less intense monitoring has occurred. In total area and relative amounts of mountain goat habitat, the Teton-Dupuyer and Deep-Sun segments are nearly identical. If the Suitable habitat in the Birch-Badger segment were discovered to have mountain goat use, reclassification of these areas would result in each of the 3 segments having equal amounts of Occupied yearlong habitat.

Summer and Winter Areas

Summer and winter mountain goat habitat is essentially the same, and is termed Yearlong habitat. Yearlong habitat occurs at elevations ranging from less than 1524 m (5000 ft) to over 2743 m (9000 ft) and on all aspects and slopes within the study area. Generally mountain goats are observed between 1829 m and 2590 m (6000-8500 ft), on north, east and south exposures, on slopes greater than 30 percent and on landtypes 202, IV, 182 and 171. In summer, mountain goats can be seen on all vegetation and terrain types, but in winter they tend to occur on crust, forest and parkland vegetation types and cliff, talus, and ridge terrain types.

Kidding-Nursery Areas

Kidding-nursery areas occur on all aspects and slopes and most elevations within the study area. Generally, they occur on east to southeast exposures on slopes of 70 percent or greater; between 1829 to 2438 m (6000-8000 ft) elevation; on landtypes 202, VI, 171 and 182; in all terrain types and on the crust, forest, parkland, short grass and brush vegetation types.

Breeding Areas

Breeding areas occur on all aspects and elevations within the study area but tend to occur on eastern exposures; on slopes of 70 percent and greater; at elevations of 2134-2438 m (7000-8000 ft); on land types, 202, VI, and 182; on cliff and bluff terrain types; and crust, forest, parkland and krummholz vegetation types.

Mineral Licks

Seventeen mineral licks are known to occur within the study area (Figures 32 to 50). The Curly Bear, Walling Reef-south, Old Man of the Hills, Bruce Creek, Nesbit Creek, and Headquarters Pass licks may be natural mineral licks, but the other 11 are artificially established sites. The Blackleaf, Curly Bear, South Fork Dupuyer, Walling Reef, Old Man of the Hills, Nesbit Creek, Our Lake, Headquarters Pass, North Fork Deep Creek, and Frenchy

Gulch sites are regularly used by goats. The Walling Reef-north, South Fork Deep Creek, and Bruce Creek licks are occasionally used. The degree of use the Blindhorse, Walling-Split Mountain, Chute Mountain, and Erosion Gulch licks receive is not known.

Mountain goats will use salt during all months of the year (DeBock 1970) but periods of use between April and December are commonly noted (Singer 1978, Rideout 1974, Hebert 1967). Along the Rocky Mountain Front males tend to use licks during May, June and early July. Females generally do not begin using licks until after the kids are born in June, but they continue to use them into September.

Mountain goat kids follow their dams for at least 2 years (photo by Lance Schelvan).

In using licks, most ungulates are seeking sodium bicarbonate (Stockstad 1953 and Smith 1954). Hebert and Cowan (1971) indicate that there is a sodium imbalance in the diet of mountain goats during spring since the diet has shifted from dry winter forage to lush green forage which tends to flush the system of essential nutrients.

The mountain goats' desire for salt is strong and will lead them into unsafe surroundings out of normal mountain goat habitat, away from escape terrain. These circumstances will develop if artificial lick sites are established near the fringes of mountain goat habitat. Rideout (1974) hypothesizes that mountain goats will risk predation to satisfy their drive and need for salt. Singer (1978) documented numerous mountain goat vehicle incidents in Glacier Park along Highway 2 where goats were trying to cross the highway to use a salt lick.

Food Habits and Feeding Site Analysis

Preliminary food habits information was collected from 34 feeding sites in the Teton-Dupuyer area from March through September 1981 (Appendix 44). Frequency of occurrence and average cover of 9 general ground cover categories and all plant species are summarized for each month and presented in Appendix 45 and 46, respectively. A total of 5 genera of trees, 21 species of shrubs, 176 species of forbs, and 30 species of grasses and grass-like plants were recorded on all feeding sites. The months having the highest average cover of shrubs, grass, and forbs were April, June, and September, respectively. March had the highest average cover of rock and snow.

Plant frequency was closely correlated with average cover during June, July, August, and September. Forbs, grass, and shrubs ranked first, second, and third in both frequency of occurrence and average cover during these months. During March, April, and May, the category which ranked first in frequency did not rank first in average cover. This may have been a function of classifying some plants, particularly penstemons, as forbs rather than shrubs.

Appendix 47 lists 78 genera or species which were noted to have been grazed upon at sampled mountain goat feeding sites. Mountain goats may not have fed upon all the species noted, since mule deer and bighorn sheep were also occasionally observed feeding in the same areas as mountain goats.

In order to quantify diet preferences of mountain goats, it is necessary to determine plant species availability in comparison to actual use. Although the feeding site data presented in Appendix 47 is a step in that direction, the data were insufficient to quantify individual plant species availability throughout seasonal mountain goat habitat.

Comparison of grass, forbs, and shrubs (Table 10) reveal that these broad forage classes tend to occur in the same relative order in fecal samples (Table 11) and on feeding sites (Appendix 47). For 5 of the 7 months in which samples were collected and exams were conducted, the first and third categories coincided, indicating a correlation between availability and forage selection. The conclusion from this is goats feed on what is available. However, sites selected by goats for feeding may not be typical of the environment as a whole, so one level of discrimination may occur when the goat selects the site on which to feed, rather than choosing between available forage classes at a particular location. In Colorado, Adams et al. (1982) established that mountain goats do feed on the forage which is available, but Dailey et al. (1984) explains that mountain goats are in fact discriminant feeders, in that they select specific plant parts on which to feed.

Table 10. Ranking of relative abundance of grass, forbs and shrubs on monthly mountain goat feeding sites on the Rocky Mountain Front, as compared to relative abundance of grass, forbs and shrubs in monthly mountain goat fecal samples.

	March	April	May	June	July	August	Sept
Grass	3/1[1/]	2/2	2/2	2/1	2/2	3/2	2/2
Forbs	2/3	3/3	3/3	1/2	1/1	1/1	1/1
Shrubs	1/2	1/1	1/1	3/3	3/3	2/3	3/3

[1/] Feeding sites/fecal samples. Five feeding sites and five fecal groups were sampled and averaged each month.

Table 11. Percentage of grass, forbs and shrubs in the diet of mountain goats along the Rocky Mountain Front from March through September 1981, as determined by microhistological analysis of fecal samples.

	Grass	Forbs	Shrubs
March	39.2	22.2	38.6
April	41.0	15.4	44.0
May	40.4	12.4	47.2
June	59.2	24.4	16.0
July	25.0	55.8	19.4
Aug	34.8	54.4	11.0
Sept	35.2	39.0	25.6

805/5

More detailed comparisons show that 41 of the 46 items (89 percent) which occurred in the fecal samples also appeared on feeding sites (Appendix 47 and 48), while 41 of the 121 genera which were known to occur on feeding sites also occurred in fecal samples. Seventy-five species, involving 52 genera, were noted to have been fed upon at feeding sites; of these, 21 (40 percent) were noted in fecal samples.

Over the 7 month sample period, an average of 81 percent (63-89 percent) of the top 10 genera which occurred in fecal samples (Appendix 49) occurred at feeding sites. Again, this would indicate that goats are feeding upon species which are available. However, if the most common species at feeding sites are compared with the most abundant species in fecal samples, the correlation is less than 50 percent, suggesting selection for some species at certain times.

Although feeding site exams provide detailed descriptions of areas where mountain goats were observed to feed, collection of pellet groups is a more efficient and less biased method of assessing food habits since they represent all habitats and all time periods in which goats fed.

The bioenergetics of other species of ungulates reveal that in order to conserve energy in winter, involuntary weight loss occurs regardless of the quantity of food available. Mountain goats too, have been noted to lose weight during winter (Casebeer et al. 1950). This appears to be an adaptation for winter survival in that less food is required to maintain a smaller body mass. In addition, ungulates also adjust their behavior in winter to minimize energy expenditure in daily activities. Mackie et al. (1980) explains that the basal metabolic rate of deer drops along with body mass and, that it is actually a combination of the animal's physiological condition upon entering winter and numerous environmental conditions (beyond simple winter forage condition) which determine winter survival. Thus, a given herd's survival strategy is determined by a specific combination of energy conservation measures and the particular habitat in which it lives. The objective in collecting food habits information has evolved from analysis of winter range condition as an index of habitat carrying capacity to research of the physiology of an animal in concert with its particular habitat or survival strategy.

Bighorn Sheep/Mountain Goat Interaction

Range Overlap

Bighorn sheep distribution along the Rocky Mountain Front was summarized and compiled from Erickson (1972), Frisina (1974), Andryk (1983), Hook (1984) and the Interagency Rocky Mountain Front Wildlife Guidelines (1984). Bighorn sheep range along the Front has been delineated during winter and lambing periods. Although their use of the Front during the remainder of the year

has not been mapped, bighorn distribution is more extensive than the winter and lambing map indicates. Current bighorn distribution occurs within all 3 mountain goat study area segments.

In the Birch-Badger segment, bighorn distribution overlaps with that of mountain goats only in the Birch Creek portion. Bighorn sheep winter range occurs largely on Transitional mountain goat habitat along the east edge of the National Forest boundary, from Walling Reef, north along Major Steele Backbone. Bighorn sheep summer range has not been delineated, so yearlong range overlap with mountain goats cannot be specifically compared. Lambing areas on Mount Sentinal, Mount Richmond, Field Creek, and Hurricane Mountain exist within Occupied yearlong mountain goat habitat.

In the Teton-Dupuyer segment, bighorn sheep winter range overlaps with mountain goat Occupied yearlong habitat primarily in the Choteau Mountain-Jones Creek area, while most of the bighorn sheep winter range extending north from Ear Mountain to Choteau Mountain occurs primarily on mountain goat Transitional habitat, and east of the mountain goat range. Lambing areas on top of Choteau Mountain and in the Bear Creek-Ear Mountain vicinity occur entirely or partly on mountain goat Occupied yearlong habitat.

In the Deep-Sun segment, bighorn sheep winter ranges overlap with mountain goat range in the following areas: Ear Mountain-South Fork Willow Creek, Deep Creek, Green Timber Gulch, Castle Reef, and the Arsenic Mountain to Reclamation Flats ridge. Lambing areas within Occupied yearlong mountain goat range include Ear Mountain-Willow Creek, Castle Reef, and the Arsenic Mountain-Reclamation Flats ridge. Three other lambing areas occur within mountain goat Transitional range.

Summer distribution of bighorn sheep is much more extensive than the limited analysis of winter range and lambing areas would indicate. Summer range overlap between bighorn sheep and mountain goats may involve greater resource overlap than during winter, due to the wider distribution of bighorn sheep and more similar food habits during this time of year.

Historical bighorn sheep distribution along the Rocky Mountain Front has fluctuated with disease related die-offs and livestock grazing (Couey and Schallenberger 1971). In 1936, Howard and McNeal (1936) indicated that "sheep continue to decrease until now there are few left on the Teton Unit (Teton River to Glacier National Park). There are no known areas in the north end of the Teton Unit that have been inhabited by sheep during the past 20 years". Schallenberger (1976) reported sightings of occasional sheep in the Badger Creek area including a young ram on Mount Baldy in July 1975, and 2 rams in the same area in 1974. Areas which are not specifically noted on the current bighorn sheep distribution map, but where summering bighorns were observed

during the Rocky Mountain Front mountain goat study include: Mount Patrick Gass (19 rams), Nanny Creek (8 rams), Bruce Creek (6 rams), Bennie Hill (1 ram), Bum Shot Mountain (10 rams), Mount Sentinal (9 rams), and throughout Biggs Creek (100+ ewes and rams).

In March 1976, 37 bighorn sheep were successfully transplanted from the Sun River drainage to the Walling Reef area (Erickson et al. 1976). Several of this group, including at least 2 of the original neckbanded ewes have been regularly observed on Walling Reef and throughout Birch Creek during mountain goat surveys or radio-relocation flights.

Social Interaction

Mountain goat social structure encourages formation of small widely spaced groups (Rideout 1974), in order to take advantage of dispersed food in broken terrain, and to decrease the potential for intraspecific competition, thus lowering aggression rates and conserving energy under adverse conditions (Smith 1976). In the dangerous terrain which mountain goats inhabit, formation of large groups for protection against predators would increase the potential for accidents, which in the case of avalanche, could lead to the demise of an entire herd (Smith 1976). Bighorn sheep do not utilize broken cliff escape terrain as consistently as do mountain goats, but group size does tend to increase with increasing distance from escape terrain (Stewart 1975, MacArthur et al. 1982), apparently to compensate for individual vulnerability.

Several observers have reported mountain goats and bighorn sheep mingling for brief periods while feeding and bedding (Smith 1954, Brandborg 1955, Stewart 1975) without signs of aggression. However, Klein (1953) indicated that Alaskan goats were indifferent to the presence of sheep but that sheep tended to avoid goats. Reed (1980) reviews the literature concerning competition between goats and sheep and cites Hibbs et al. (1969) and others in thier philosophy that mountain goat-bighorn sheep competition is minimal except when both species occupy common winter ranges at lower (subalpine or montane) elevations. If crucial resource shortages were to materialize on sympatric ranges however, it is believed that mountain goats would become the aggressors, as demonstrated by their dominance over deer (Brandborg 1955), and sheep (McCrory 1965) at mineral licks, and their highly agonistic intraspecific behavior (Chadwick 1973) particularly under severe winter conditions (Petocz 1972).

Forage Selection

Comparison of mountain goat late winter forage selection (this report) with that of mule deer, elk, bighorn sheep, and cattle (Kasworm et al. 1984) along the Rocky Mountain Front, indicates that the potential for forage competition is greatest with bighorn sheep. A comparison of the combined March-April fecal

samples from mountain goats, bighorn sheep, elk and mule deer provides the following percentage occurrence results in each of the forage categories grass, forbs, and shrubs: 40.1, 18.8, and 41.3 percent, respectively, for mountain goats; 46.7, 11.7, and 41.7 percent, respectively, for bighorn sheep; 65.4, 29.2, and 5.5 percent, respectively, for elk; and 13.7, 8.7, and 77.7 percent, respectively, for mule deer.

Comparing the combined June-August fecal samples for mountain goats (Table 11) and bighorn sheep (Andryk 1984) reveals very similar diets. Percent occurrence of grass, forbs, and shrubs was 39.7, 44.9, 15.5 and 42.5, 48.1, 9.4, respectively. The diet of cattle at this time of year (Kasworm et al. 1984) along the Rocky Mountain Front was composed of 84.3 percent grass, 11.5 percent forbs, and 4.2 percent shrubs.

Mountain goats utilize a wider range of forage than do bighorn sheep, but they are more selective in the parts of the plant they eat than are bighorn sheep (photo by Jim Posewitz).

Dailey et al. (1984), in their analysis of mountain goat and bighorn sheep forage competition in Colorado, concluded that goats and sheep grazing on the same alpine sites chose similar diets during summer, but not during winter. Their findings of increased divergence in diet composition and quality between mountain goats and bighorn sheep during winter, a period of nutritional stress, concurred with the findings of McArthur (1972:21) and Weins (1977), that resource-use traits of animals should reflect periods when resources are most limiting and competition for those resources is keenest. Dailey et al. (1984) cites several sources in a review by Schoener (1982), which conclude that diet overlap of sympatric animals shrinks during times of resource scarcity.

Consistent with Dailey et al. (1984) findings that goats are more selective plant-part feeders than sheep, are the physiological distinctions of the digestive tracts described by Hofmann (1984) between chamois (Rupicapra rupicapra) and mouflon (Ovis ammon musimon). The chamois is the European counterpart of the North American mountain goat (and in fact is a close taxonomic relative), while Europe's mouflon is analagous to the bighorn sheep. Hofmann (1984) explains that chamois show all the morphological signs of an intermediate, opportunistic ruminant utilizing a mixed diet, but selecting whenever possible for cell wall content rather than for cell wall, ie. fiber. This has led to a digestive strategy much different from wild sheep which are well able to digest poor, fibrous food throughout the year. Cyclic internal (mucosal) changes in chamois are dramatic, which allows them to become extremely efficient concentrate selectors between June and October. During the fall, a digestive transformation occurs which allows fiber digestion during winter, so that they are capable of bridging the dangerous gap between exhaustion of fat deposits and the arrival of new vegetation.

A combination of seasonal resource partitioning, as described by Schoener (1982), and the possibility of distinct digestive capabilities (Hofmann 1984) between mountain goats and bighorns, suggests that competition, if it does occur between these species on the Rocky Mountain Front, is likely to surface during summer when the cumulative effects from competition with livestock, energy exploration, and recreationists are compounding sheep and goat habitat overlap. These cumulative impacts may be precipitating nutritional complications for both species, either from the stress of the activities themselves or from the secondary effect of increased range overlap, or both. Because of these conflicts, summer may be a more critical time of year than winter for both mountain goats and bighorn sheep along the Front.

Ecological Relationships

Adams et al. (1982) describe the ecological relationships of mountain goats and bighorn sheep. According to their conceptual

model, the niches of the 2 species in Colorado overlap by roughly 15 percent under normal conditions. Habitat pressures (impacts) can force 1 species to invade the niche of the other which will result in increased competition (as has occurred in Colorado). Each species is adapted to exploit its niche in a slightly different way. Bighorn sheep are physically adapted to utilize a wide range of terrain types, given certain limitations, but they are quite selective in their feeding habits, whereas mountain goats are physically adapted for rugged, steep terrain and can exploit these areas even under adverse conditions. Because of their limited habitat selection, goats must accept a wide range of forages (Adams et al. 1982). Mountain goats do not feed indiscriminantly, however. Dailey et al. (1984) explains that plant parts selected by mountain goats are more nutritious than those selected by sheep. So while mountain goats are more flexible in their feeding habits than are bighorn sheep, bighorns are able to utilize a wider variety of habitat types.

Mountain goats are highly sensitive to weather, particularly heavy winter snowfall, while sheep are not as demographically susceptible to changes in weather (Geist 1982). According to Geist (1982), since goats can be readily alienated from their home ranges, and since hunting mortality appears to be additive, and since no compensatory reproduction follows death of adults; a series of hard winters, plus increased human encroachment, can rapidly depress goat populations.

An extensive review of interrelationships of bighorn sheep and domestic sheep is presented by Goodson (1982), in which the competitive factors of forage, space, and disease are discussed. She states that bighorns and domestic sheep have similar food preferences, and that domestic sheep are capable of using steep slopes which cattle cannot, but "where individual bighorns have been observed in association with domestic sheep, avoidance is the rule. This avoidance can lead to bighorns occupying only part of the available habitat. Co-use of ranges by domestic and bighorn sheep has been consistently linked with declines, die-offs, and extinctions of bighorn sheep populations from historical to recent times". Livestock grazing upon bighorn sheep ranges, particularly by domestic sheep, can impact mountain goats by displacing sheep from preferred areas into the rugged limits of their range which they share with mountain goats.

Bighorn sheep are less able to adapt to rapid habitat changes and increased harassment resulting from development of their range for man's use, and they are less tolerant of poor range and interspecific competition that are most other wild ungulates, (Goodson 1982).

Clearly, sheep along the RMF are likely to suffer if human activities impose stress upon the population, or induce range overlap with other wildlife species. And in fact, Hook (1986) cites a pneumonia-related die-off in sheep in the Sun River area

subsequent to intense seismic activity. Pasteurella hemolytica biotype T was implicated in the die-off, and is known to be a stress-induced disease. The species specific lungworms which can be a contributing factor to this malady, are shared with mountain goats. A similar decline in the mountain goat population along the Front, coincident with energy exploration activities, is discussed in (Appendix 18). The ecological relationship between mountain goats, bighorn sheep, transmissable parasites, stress-induced disease, and human activity within this area mertis conscientious monitoring.

Both mountain goats and bighorn sheep stand to suffer if they are forced to use more limited, more overlapping habitat as a result of human development and harassment. Mountain goats may be indirectly impacted due to disruption of bighorn sheep habitat outside of identified mountain goat range on the Rocky Mountain Front. When bighorns are forced to use mountain goat habitat, the potential increases for both forage and special competition between these species.

Human Activities

The majority of land within the Rocky Mountain Front mountain goat study area is administered by the Lewis and Clark National Forest (94.1 percent), followed by the BLM (3.0 percent), private groups or individuals (1.5 percent), and the State of Montana (1.4 percent) (Table 12). This land ownership pattern dictates the type and extent of human activity which occurs within mountain goat habitat along the Front. In addition to information and literature sources provided here, Appendix 50 provided a limited annotated bibliography of human development impacts upon various wildlife species with emphasis on mountain goats.

Oil and Gas Exploration

Oil and gas exploration and development have recently become major land use activities on the Rocky Mountain Front. In order to assess the response of mountain goats to this activity, information was gathered concerning the intensity, extent and duration of oil and gas exploration and development along the Front.

Exploration activities employ a number of methods including surface charges, portable drilling, deep shot holes, vibroseis and magneto-tellurics - each of which requires a series of support activities implemented by individual crews. The amount of human activity associated with a seismic line run in roadless mountainous country varies according to the terrain, weather conditions, and the company conducting the work. Seismic records kept by Rocky Mountain Ranger District personnel (R. Strathy geologist, and L. Young biologist) on the RMF corraborate information collected in similar circumstances in northwest

Wyoming by Hoskins (1981). Both report that 19 to 20 individuals are involved with line execution, including: 4 man survey crew (2 chainers, surveyor and rodman), 4 man layout crew, 5 man shooting crew, 2 man recording crew, and 3 to 5 man pickup/trashing crew. Hoskins (1981) reported line progress at 1.0-1.3 km per day, which is similar to that of the RMF. Two helicopters are generally used for transporting crews and equipment. An estimated minimum of 8 km helicopter flying is associated with each km of seismic line.

Energy exploration information from 1981 through 1985 is presented in Table 13. Over 670 km of seismic lines have been shot in mountain goat habitat along the RMF since 1981, with about equal amounts occurring in both Occupied yearlong habitat (315 km) and Transitional habitat (312 km). Twice as much line has been shot in the Birch-Badger segment (413 km) as in the Teton-Dupuyer segment (203 km), but over 75 percent of the latter has been in Occupied mountain goat habitat. Over the past 5 years, the Birch-Badger segment has received the greatest exploration pressure. Over 195 km of line was shot in this segment in 1984 alone. Figure 51 illustrates the distribution of seismic lines within mountain goat habitat.

Since 1981, 2 exploratory wells have been drilled within mountain goat habitat in the Blackleaf-Muddy creek area. One was drilled on Transitional range less than 1 km from Occupied habitat. The other was drilled on the edge of Occupied habitat. Radio-marked mountain goats tended to avoid these areas during the period of activity, but unmarked goats were observed in the vicinity of the drill rig. A third well on the edge of Occupied habitat in Muddy Creek is scheduled for drilling pending approval of the Application for Permit to Drill (APD). There are 4 other shut-in wells in the Blackleaf area. A well in the North Fork Badger Creek on Goat Mountain within Occupied mountain goat habitat has been staked by Chevron; an APD is pending. An exploratory well in this area would require significant road construction that would deeply penetrate the Birch-Badger segment, and create ready access into mountain goat range.

The Lewis and Clark National Forest Plan (LCNFP, 1986) displays a hypothetical gas field development and processing scenario in the North and South Forks of Badger Creek. Ramifications from exploratory drilling are contingent upon the fate of the roads which access the sites. In order to achieve negligible long-term impacts, the road bed must be reclaimed to its original state. However, that would not be possible if gas or oil is discovered. In that case, the road must instead be maintained for development and production access, and the impacts which might have been almost entirely mitigated would instead be magnified.

Mountains goat response to seismic lines was recorded in 1983 when a line was set up in the Blackleaf canyon. Four radio marked goats in that drainage moved into adjacent drainages even

Table 12. Percent land ownership within each type of mountain goat habitat in each study area segment of the Rocky Mountain Front.

	BIRCH - BADGER				TETON - DUPUYER				DEEP - SUN				TOTAL			
	%				%				%				%			
LAND OWNERSHIP	1[1]	2	3	Tot	1	2	3	Tot	1	2	3	TOT	1	2	3	TOT
Forest Service (1221.2 km²)	100	95.8	96.5	98.0	96.0	---	73.0	89.7	93.5	95.4	91.7	93.1	96.4	95.7	90.1	94.1
BLM (38.7 km²)	---	---	---	---	1.0	---	13.4	4.4	6.1	4.6	4.9	5.7	2.4	1.0	4.2	3.0
State (18.8 km²)	---	---	---	---	2.7	---	10.6	4.9	---	---	---	---	1.0	---	2.4	1.4
Private (19.3 km²)	---	4.2	3.5	2.0	0.3	---	3.0	1.0	0.4	---	3.3	1.2	0.2	3.2	3.3	1.5
Total (1298.0 km²)	238.9	39.6	251.8	530.3	279.7	---	105.8	285.5	260.8	12.0	109.4	382.2	779.5	51.6	466.9	1298.0

[1] 1 = Occupied yearlong habitat, 2 = suitable low occupancy habitat, 3 = transitional habitat.

Table 13. Kilometers of seismic line conducted within mountain goat habitat along the Rocky Mountain Front, 1981-1985.

Seismic Lines	BIRCH-BADGER				TETON-DUPUYER				DEEP-SUN			
	Occup.[1]	Suit.	Trans.	Total	Occup.	Suit.	Trans.	Total	Occup.	Suit.	Trans.	Total
1981 (195.5 km)[2]	31.1	10.4	48.4	89.9	70.7	-	15.1	85.9	19.3	-	0.4	19.7
1982 (37.0 km)	6.3	3.5	18.1	27.9	0.3	-	0.7	1.0	8.1	-	-	8.1
1983 (167.4 km)	8.0	17.1	67.4	92.5	40.4	-	18.7	59.2	15.0	-	0.7	15.7
1984 (271.5 km)	55.7	20.1	120.6	196.4	42.7	-	14.9	57.4	15.2	-	2.5	17.7
1985 (4.8 km)	2.4	-	4.4	6.8	-	-	-	-	-	-	-	-
TOTAL (678.2 km)	103.5	51.1	258.9	413.5	154.1	-	49.4	203.5	57.6	-	3.6	61.2

[1] Occup. = Occupied habitat, Suit. = Suitable habitat, Trans. = Transitional habitat

[2] Total km seismic line shot within study area, 1981.

before the blasting occurred. Similarly on Walling Reef (Andryk and Irby 1986), 4 adult goats, as well as a band of sheep, all left the area of a seismic test within 24 hours after the blasting. Immediate responses to actual blasting range from no apparent change in activity to leaping out of their beds and running in confusion. Considering the regular occurrence of electrical storms, avalanches and falling boulders in mountain goat terrain, the presence of people is probably more disturbing than seismic blasts. The interaction between mountain goats and energy exploration along the RMF is detailed in Appendix 18. The recent population decline along the Front may be in part the result of energy exploration activity.

Energy development within mountain goat habitat is discouraged, but exploration can be conducted without resulting in long lasting effects, if the proper measures are taken to reduce or avoid impacts (photo by Gayle Joslin).

The apparent nonchalant attitude of mountain goats is a crucial feature of their adaptive strategy since they cannot afford to panic in dangerously steep terrain. Physiological changes typical of stress no doubt occur in mountain goats as they do in other species of ungulates when something out of the ordinary occurs. These changes generally include increased hormone levels (Thompson 1957, Denenberg and Rosenberg 1967), raised heart rates (MacArthur et al. 1979) and respiration, as well as increased metabolic levels (Webster and Blaxter 1966 and Blaxter 1962 in Geist 1978). The consequences of chronic stress are insidious and difficult to document. They may show up as reduced feeding time (Kiley 1974), yet when under stress there is an increased need even for basal metabolic rates (Geist 1978), plus the additional needs of the active inhibition period. In addition, there may be increased fetal abortion and resorption (Geist 1971), reduced reproduction (Reid and Miles 1962 in Geist 1978), avoidance of certain areas resulting in loss of access to resources and, ultimately, reduced population (Batcheler 1968 in Geist 1978).

Geist (1975) states, "Harassment comprises actions which in vertebrates precipitate a spectrum of responses, from excitation on one hand to exertion, stress, and even illness and death on the other. Harassment by elevating the cost of living to individuals reduces their growth. Development and reproduction; it can and does lead to death, illness and reduced reproduction due to secondary effects of physical exertion and temporary confusion; it can and does lead to avoidance or abandonment of areas in which harassment was experienced leading to range losses, increased predation or increased cost of existence, which are reflected in loss of individuals and population quality. . . It is important to note that anthropomorphism is not a reliable guide to what is or is not harassing to animals".

Most wildlife react adversely to aircraft. Shank (1979) indicates that mountain goats react more strongly to aircraft than do most other ungulates. In an analysis of mountain goat response to hydroelectric exploration, Foster and Rahs (1985) report that more than 80% of observed goats elicited some form of behavioral stress response, with 33% displaying a severe flight response, primarily from aircraft. Minimum helicopter flight heights have been recommended by Miller and Gunn (1980) of 300 m, Calef et al. (1976) of 300 m, McCourt et al. (1974) of 300 m, Geist (1975) of 600 m, and Foster and Rahs (1985) of 600 m. Klein (1973), and DeBock and Surrendi (1974) show that considerable caribou disturbance still occurs during overflights exceeding 200 m, and yet the authors "failed to determine the effect of harassment on caribou in terms of physiology, reproduction, mortality or bioenergetics, and it is that which must be known rather than whether harassment occurred or not" (Geist 1975).

To avoid or minimize adverse consequences of energy exploration activities upon mountain goats, strict adherence to the management guidelines (Appendix 17), with a recommended alteration in flight height from 200 m to 300 m, is necessary. These guidelines are based on knowledge of mountain goat movement patterns, home range sizes, mortality causes and behavioral traits.

Vehicle Access

Where human activity has had long-lasting effects upon mountain goats, vehicle access is generally to blame. Roads have been linked to mountain goat population declines across their range in North America. Although the actual mechanism which precipitates population decline, whether it is increased legal and illegal hunting (Kuck 1977, Hebert and Turnbull 1977), habitat destruction (Pendergast and Bindernagle 1977), home range (Geist 1982) or behavioral disruption (Chadwick 1973), the catalyst for the decline is usually road construction into mountain goat habitat.

Currently on the Lewis and Clark National Forest, nearly 3,220 km (2,000 mi) of road exist (250 km arterial, 1,035 km collector, 961 km local, and about 1,000 km primitive) (LCNFP 1986). Under current management, the arterial collector road system would increase about 5 km per year, while timber support local roads would increase about 24 km per year. Within the Rocky Mountain Division, permanent roads will not be constructed in conjunction with timber removal, but unprogrammed timber harvest may occur in the Badger-Two Medicine as well as in the North and South Forks of the Teton which will also be partially managed under the Timber/Range prescription (LCNFP 1986). About one-third of this area is Occupied yearlong mountain goat habitat while the remainder is Transitional habitat. Exploratory drilling for oil and gas poses the greatest threat to mountain goat habitat from road development. The pending well at Goat Mountain promises to be a classic case of roads penetrating mountain goat habitat as natural resources are developed.

Table 14 describes relative abundance of roads occurring within each type of mountain goat habitat in each study area segment. The Teton-Dupuyer segment contains the most roads (54 km), followed by Birch-Badger (38 km), and Deep-Sun (12 km). The only roads open to vehicles over 40 inches (102 cm) in width now existing within Occupied habitat (4.5 km) occur in the Teton-Dupuyer segment. Occupied habitat in all 3 segments receives mechanized use by snowmobilers. An effort should be made to identify and map all critical wintering areas which snowmobilers should avoid.

Livestock Grazing

All grazing allotments and outfitter packstock allotments are numbered and administrative units lettered in Figure to coincide with individual names in the text. Several terms pertinent to livestock grazing which are used in this discussion need clarification. An Animal Unit Month (AUM) is the standard unit of measure used in calculating livestock stocking rates. One AUM is equivalent to the combination of one cow and one calf grazing for one month. An Animal Month (AM) is one animal grazing for one month. One ewe/lamb unit grazing for one month is an AM. A cow/calf unit grazing for one month is 1.32 AM. One horse grazing for one month is an AM. The AUM equivalents for 1 AM sheep (ewe/lamb) = 0.3 AUM, 1.32 AM cattle (cow/calf) = 1.0 AUM, 1 AM horse = 1.25 AUM. The Rocky Mountain Ranger District files generally record livestock grazing information in AMs. An ON-OFF grazing system is generally used where federal land abuts unfenced private land, and the Forest does not run the area as a separate unit. Allotted AUMs on the federal lands are based on the percentage of the allotment which is composed of federal lands. If, for example, the federal land comprises 10 percent of the area grazed, and has the same grazing potential as the rest of the area, then 10 percent of the AUMs are prescribed for the federal portion of that grazing allotment. However, since free access exists between the private and public land, livestock distribution is not regulated.

Grazing Allotments

Distribution of 15 grazing allotments or allotment divisions along the Rocky Mountain Front is presented in Figure 52. Allotment overlap with Occupied mountain goat habitat is greatest in the Deep-Sun segment (Table 14), although current allowable AUMs (377) appears to be less than in either the Teton-Dupuyer (986) or Birch-Badger segments (2660).

Five allotments in the Birch-Badger segment, overlapping with 48.6 km^2 of mountain goat habitat (Table 14), include Lubec-Badger (Lubec and Badger divisions), Little Badger, Sawmill, Heart Butte (Mowitch Basin and Whitetail divisions), and Sheep Creek.

The Badger (number 1 in Figure 52) division of the Lubec-Badger allotment was grazed as part of the old Glacier division since prior to 1911 when use by 8,000 sheep was authorized. From 1930 to 1945 range use was limited to 1250 sheep during the period July 1 to September 15. In 1946, the allotment was converted to cattle. Since 1964, a 3 pasture rest-rotation program has been in effect. Since 1980, the period of use has been June 21 to

Table 14. Relative occurrence of roads, grazing allotments, packer allottments, and administrative units within each type of mountain goat habitat in each study area segment of the Rocky Mountain Front.

	BIRCH - BADGER				TETON - DUPUYER				DEEP - SUN				TOTAL			
		%				%				%				%		
	1[1/]	2	3	Tot	1	2	3	Tot	1	2	3	TOT	1	2	3	TOT
Roads (km)	---	8.2	91.8	100.0 (38.2)	8.4	---	91.6	100.00 (53.8)	---	---	100	100.0 (12.3)	4.3	3.0	92.7	100.0 (104.2)
Grazing Allotments (km^2)	26.8	15.0	58.2	100.0 (48.6)	73.5	---	26.5	100.0 (72.2)	86.0	---	14.0	100.0 (69.2)	10.1	43.6	46.3	100.0 (190.0)
Packer Allotments (km^2)	100.0	---	---	100.0 (4.9)	73.9	---	26.1	100.0 (34.6)	36.1	---	63.9	100.0 (41.5)	56.1	---	43.9	100.0 (81.0)
Administrative Units (km^2)	100.0	---	---	100.0 (0.3)	92.6	---	7.4	100.0 (50.4)	84.1	4.9	11.0	100.0 (10.9)	91.2	0.9	7.9	100.0 (61.6)

[1/] 1 = Occupied yearlong habitat, 2 = suitable low occupancy habitat, 3 = transitional habitat.

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September 10. Current AUM authorization is 1226 (LCNFP, 1985). Four pastures exist in the Lubec (2) division but no further information is available relative to the history of this division. The total AUM allocation for the Lubec-Badger allotment is 1618 (LCNFP, 1986).

First recorded use of the Little Badger (3) allotment was by horses in 1911. In 1917, use by 1,500 sheep was allowed from July 1 to September 30. From 1917 to 1928, between 1,500 and 2,065 sheep used the area. In 1928, use was limited to 1,250. In 1931, the period of use was changed to July 5 to September 15 for 1,000 sheep, where it remained until 1960 when the use period was again changed to July 1 to August 31. This period was in effect until 1969 when herding was implemented. Two thousand AMs used the site in 1982, although 600 AUMs are allocated.

The Sawmill (4) allotment is continuous with the Blackfeet Indian Reservation, so livestock use is not be carefully regulated. This allotment is noted for its use by wildlife. According to the file on this allotment, substantial competition with bears exists. Prior to 1955, sheep were permitted, then from 1955 to 1968, 300 AMs of cattle were permitted. The allotment was not used from 1969 to 1971. From 1972 to 1978, 75 AMs of cattle were allowed then the AMs were increased to 175 in 1979. The period of use since 1982 has been July 1 to September 15. The LCNFP (1986) indicates that a portion of this allotment, with an AUM capability of 460, has been closed, although the active portion has an allocation of 231 AUMs.

The Heart Butte allotment is composed of the Mowitch Basin and Whitetail divisions. The area was grazed by Indian horses from 1897 to 1910. Mowitch Basin (5) was grazed from 1912 to 1920 for 30 months by 1,500 to 2,000 sheep. Through 1950, 800 to 1,500 head of sheep grazed the area for 2.5 months. The allotment was converted to cattle in 1951, but from 1951 to 1958 it received little use and then no use until 1965 when 30 head of cattle were allowed during the July 1 to September 10 period. Currently, 105 AMs are allowed. Trespass by Indian horses continues to be a problem according to file information. The Whitetail (6) division was used by 300 cattle in 1909. There was significant interchange by sheep between these 2 divisions in the early years. In 1951, the division was set up on an ON-OFF system. The period of use is from June 21 to September 15 for 57 AMs. Currently 214 AUMs are allocated for the entire allotment (LCNFP, 1986).

Five allotments in the Teton-Dupuyer segment overlap with 72.2 km^2 of mountain goat range. They include Sheep Creek, Scoffin Creek, Dupuyer, Cow Creek, and Chicken Coulee. The Sheep Creek (7) allotment has been closed since 1974, according to the file, when use was relinquished to big game. Primary competition mentioned was with mountain goats. The area had been grazed by cattle since 1889. Overstocking on this subalpine range reduced an already low productivity. Use was limited to only the forks of Sheep Creek in 1966 during the period July 1 to August 31, then in 1974 this allotment was closed.

The Scoffin Creek (8) allotment has received cattle use since 1889. This allotment was its own entity until 1932 when it was combined with the Dupuyer allotment until 1968, and then it was once again separated. The period of use was June 10 to September 30 from 1935 to 1982 when it was shortened to July 1 to August 31. Livestock which have been observed trespassing onto Walling Reef in the Bob Marshall Wilderness may be coming from this allotment. Current AMs are 218 although 288 AUMs are allocated (LCNFP, 1986).

The Dupuyer (9) allotment has been used by cattle since 1889. The period of use was from June 19 to September 30 when 305 cattle were run on the area. This number was reduced to 200, then in 1971 the period of use from July 1 to August 31 for 67 AMs was established. In 1982, the AMs were expanded to 201 during the period July 1 to September 10. Current allowable AUMs are 265 (LCNFP, 1986).

The Cow Creek (10) allotment was first used by cattle in 1889. The current period of use is from July 1 to September 5 for 221 AMs. The current AUM allocation is 292 (LCNFP, 1986).

Until 1969, the Chicken Coulee (11) allotment was part of the much larger Teton allotment which encompassed all of the grazing area on the Teton, Blackleaf, and Deep Creek drainages. This huge allotment was reduced in 1957 to encompass the Chicken Coulee, Jones Creek, and Clary Coulee divisions. In 1969, Jones Creek was separated and Clary was closed in 1970 (now part of an outfitter allotment). Since 1955, this allotment was run on an ON-OFF system for 170 AMs. In 1982, this allotment was designed to coincide with the associated BLM allotment. Since 1982, the period of use has been July 1 to September 20 for 141 AMs, although when combined with the BLM allotment, 235 AMs are allocated from July 1 to September 30. The current AUM allocation is 141 (LCNFP 1986).

Three allotments in the Deep-Sun segment overlap with 69.2 km^2 of mountain goat range. They include Deep Creek, Salmond, and Castle Reef. The Deep Creek allotment includes the North Fork (12) and South Fork (13) divisions. This allotment was grazed by sheep prior to 1915 and by cattle since. Prior to 1941, this was part of the Teton allotment. In 1961, the Ear Mountain and Salmond allotments were separated from this larger allotment. In 1970, a portion of Slim Gulch was removed due to fragile soils and "deferred to big game". Billie Creek was also withdrawn from livestock grazing. Since 1982, 3 units under these 2 divisions have been managed on a rest-rotation system from July 1 to September 5 for 249 AMs. Currently, 329 AUMs are allocated (LCNFP, 1986).

The Salmond (14) allotment has been grazed by cattle since at least 1941 for 200 head on an ON-OFF basis. Forest Service files indicate that there is "competition between bighorn sheep, mountain goats, elk, and deer for use of this range. The

ultimate objective for use of this range is to reserve it for big game use." Current livestock use extends from June 15 to September 1 for 38 AMs, although allocated AUMs are 48 (LCNFP, 1986).

The Castle Reef (15) allotment was closed in 1973. From 1915 to 1918, 750 cattle AUMs were allowed from May 1 to October 31. The AUMs were reduced to 650 in 1919 until 1922. In 1926 the allotment was extended west to Wagner Hill. In 1962, an ON-OFF system was implemented for 8 head of cattle which involved 5 percent use by 150 cattle from June 21 to September 15.

Outfitter Grazing Allotments

Six outfitter allotments occur within the Rocky Mountain Front study area (Table and Figure). A total of 448 AUMs were allocated on outfitter grazing allotments on the Rocky Mountain Front, in or near the Birch-Badger (30), Teton-Dupuyer (40), and Deep-Sun (378) mountain goat study area segments.

One outfitter allotment occurs in the Birch-Badger segment of the study area. The South Fork Birch (number 1 in Figure) allotment occurs entirely within Occupied yearlong mountain goat habitat at the head of the South Fork. The use period is from October 18 to November 24. Fifteen horses have been using this allotment; 30 AUMs are allocated (LCNFP, 1986).

In the Teton-Dupuyer segment, 1 allotment occurs in the Middle Fork Teton (2). The use period is from July 1 to September 6 for 43 AMs. Forty AUMs are allocated (LCNFP, 1986). This large allotment extends the length and width of the Middle Fork, and up Clary Coulee. The majority of it occurs in Occupied yearlong mountain goat habitat. The file indicates possible competition with elk and mountain goats in the Teton Peak area. The file also suggests reduced use of Lonesome Ridge to help limit soil erosion.

Four outfitter allotments exist in the Deep-Sun segment. The Wrong Creek (3) allotment occurs on the edge of the study area and extends into Occupied yearlong mountain goat habitat. The use period as of 1982, for 20 AMs, was July 1 to November 30; the allotted AUMs is 5 (LCNFP, 1986).

The first recorded use of the Biggs Creek (4) allotment was by cattle in 1905. Consistent cattle use occurred from 1912 to 1933. In fact, the entire Sun River drainage, north of the North Fork of the Sun was grazed for 15 seasons by cattle, sheep, and horses until 1913 when the Sun River Game Preserve was created, and all livestock were removed west of the North Fork of the Sun. In 1912, 1,600 head used the area from May 1 to October 31. By 1933, 800 head of cattle were grazing the area from June 1 to September 30. After 1933, the area was used only by outfitters and recreationists. This type of use peaked between 1957 and

1962 and since this time, there has been a drop in fall use (October-November), but an increase in summer use (July-August). Permitted commercial stock use averaged 110 AMs per year over the past 10 years. Actual use has been 127 AMs. Private use has averaged 80 AMs per year. The area's capacity is 240 AMs. Current levels are 76 AMs for the period July 1 to December 31; allotted AUMs are 74 (LCNFP, 1986).

The Sun Butte (5) outfitter allotment was originally part of the much larger North Fork Sun allotment which included Mortimer Gulch. It received cattle use in the early 1900's. There was no grazing from 1915 to 1924, then 29 horses were turned out. This number increased to more than 100. In 1950, the area had 420 AMs, then 380 in 1951, 315 in 1970, then 202. Currently it has 189 AMs during the June 16 to November 24 period. The file indicates that there may be competition for forage with bighorn sheep, deer, and elk. Allotted AUMs are 227 (LCNFP, 1986).

The history of the Mortimer Gulch (6) allotment is similar to that of Sun Butte. It supported from 89 to over 300 cattle from 1912 to 1929. When Gibson Reservoir was completed in 1929, most of the suitable range in this allotment had been flooded. In 1935, from 15 to 35 head were grazed for a total of 60 to 100 AMs. Considerable trespass on this allotment resulted in greatly exceeding the allowable use. In 1982, 60 AMs were grazed during the period June 16 to October 15. Seventy-two AUMs are allocated (LCNFP, 1986).

In most cases, current AUM levels for both permitted cattle and sheep allotments and outfitter packstock allotments are below allocations. Until recently, livestock grazing was probably the primary land-use activity on much of the mountain goat range along the Rocky Mountain Front. Now, energy exploration adds another type of effect, and impacts upon mountain goats accumulate. As competition for the land base becomes more intense, each land use activity should be carefully scrutinized. Since mountain goats and other wildlife have adjusted to the current AUM levels, the maximum allowable AUM rates should be revised to present levels to avoid yet another impact from increased grazing.

Administrative Units

Nine administrative units occur within or adjacent to mountain goat habitat on the Rocky Mountain Front (Table 14 and Figure 52). AM figures are for horses and mules unless otherwise stated. A total of 239 AUMs were allocated on administrative units on the Rocky Mountain Front, in or near the Birch-Badger (42), Teton-Dupuyer (126), and Deep-Sun (71) mountain goat study area segments.

The Palookaville (letter A in Figure 52) and Badger (8) units occur adjacent to and within Transitional mountain goat habitat in the Birch-Badger segment of the study area, respectively. A 5 month grazing period on both units, from June 1 to October 31,

accommodates 30 and 24 AMs on Palookaville and Badger respectively. Twenty-two and 20 AUMs (LCNFP, 1986) are specified for these administrative units, respectively.

Four administrative units occur in or near the Teton-Dupuyer segment, including Blackleaf, West Fork Teton, Jones Creek, and Ear Mountain. The Blackleaf (C) unit has been grazed by cattle since 1941. The season was shortened from June 16 - September 30 to July 1 - August 30 and the number of stock were reduced from 85 to 30 for a total of 60 AMs. The Forest Service began grazing 60 AMs of horses and mules in this unit in April and May, 1973. This unit is the Forest Service's late winter pasture for pack stock. Grazing occurs primarily during April and May, but often extends into June. The file indicates that the only possibility of wildlife conflict is with elk; however, information from this study has shown that the Mount Frazier to Volcano Reef area is extensively used by mountain goats yearlong, and receives concentrated use at the Blackleaf mineral lick from May through July. The 1984 AM level was 33 while the allotted AUMs is 48 (LCNFP, 1986).

The West Fork (D) administrative unit receives 12 AMs of intermittent use during the July 1 to November 1 period. This administrative site was constructed by the YCC and was first used in 1979. It occurs on the boundary of Occupied and Transitional mountain goat habitat. Current use was 25.2 AMs in 1984; allotted AUMs is 6 (LCNFP, 1986).

The Jones Creek (E) administrative unit was originally part of the very large Teton allotment, which was divided up in 1957, and then again in 1969. The current allotment was established in 1969. The area was grazed by 300 head of cattle in 1904, then in 1912 it was used by sheep, but in 1915, it reverted to cattle. The grazing period was May 15 to October 31. Several use period changes ensued, but the current memorandum states a use period of July 1 to August 31. Mules and horses were first grazed on this allotment in 1973. Records indicate the area can support 50 AMs of cattle or 60 AMs of horses since horses are capable of grazing more of the secondary range. About (3.2 acres) per horse month is required. Since water is limiting during the summer, this allotment is managed for fall grazing. No wildlife conflicts were noted in the files, but Jones Creek is an important bighorn sheep range, and information from this study indicate all but the creekbottom is Occupied yearlong mountain goat habitat. Since 1984, 52.2 AMs have been allowed; 72 AUMs are allocated (LCNFP, 1986).

The Ear Mountain (F) administrative unit occurs outside of the study area. Forty-five AMs during the period June 1 to November 1 have recently used the area, although 56 AUMs are allocated (LCNFP, 1986). Ear Mountain is important bighorn sheep habitat (Andryk 1983). If wildlife conflicts were to develop it would be

with bighorns directly, and possibly indirectly with mountain goats if sheep were displaced.

Three administrative units occur in or near mountain goat range within the Deep-Sun segment of the study area. No information was available concerning the Wrong Creek (G) administrative site, but it does not occur within mountain goat habitat. The Cabin Creek (H) unit occurs within mountain goat Transitional habitat. The livestock use (5 AMs) period is intermittent from July 1 to November 1. Five AUMs are allotted (LCNFP 1986).The Hannon Gulch (I) administrative unit occurs just outside the study area. In 1974, 74 AMs used this unit; sixty-six AUMs are allotted (LCNFP, 1986). More recently, the area has received 50 AMs of use from May 1 to August 30.

Consistent with the livestock grazing allotments, current use levels, if they are at or below allocated AUMs, should be maintained on administrative units. There appears to be some inconsistency between grazing allotments and administrative grazing units in that the levels of actual use are below permitted use on outfitter and grazing allotments, while actual use of some administrative sites is above the allocated use. Use should be reduced to designated levels where it is exceeding allocated use on administrative sites.

An effort should be made to quantify wildlife conflicts on all areas grazed by livestock on the Rocky Mountain Front. Management direction for the pertinent prescription areas should be assessed in lieu of the 1986 Lewis and Clark National Forest Plan, and wildlife needs.

Timber Harvest

Timber harvest on the entire Lewis and Clark National Forest has averaged 13 million board feet per year. About 8 percent of that occurred on the Rocky Mountain division. Since future sales on this division are classified in the small category, they are not addressed in the Forest Plan, rather they are handled on an individual basis under the authority of the district ranger. Green Gulch, the only active timber sale along the Front, will be completed by 1987. The LCNFP (1986) projects annual harvest at ½ million boardfeet along the Rocky Mountain Front. Four areas specified for timber management are identified in the LCNFP (1986) and include West Fork Teton; Waldron Creek; Mill Falls-Lonesome Ridge area north of the South Fork Teton; and South, Green, and Reirdon gulches at the head of the South Fork Teton. About two-thirds of the area in these designated Timber/Range Management Areas occurs on mountain goat Transitional habitat, while one-third occurs on Occupied yearlong habitat. Actual location of future sales are not known. While most timbered land along the Front is unprogrammed, it still occurs in the timber base. The majority of this land is covered by prescriptions which call for harvesting unprogrammed timber, including miscellaneous wood products, firewood, ornamentals, and

Christmas trees through administrative use, free use, permits, salvage, and sanitation cutting (LCNFP 1986).

Logging/mountain goat relationships are not well understood, but a combination of increased road access, poor road placement, and cover removal were factors in the declines of mountain goat herds in British Columbia (Phelps et al. 1975), the Swan Range (Chadwick 1973), and the Cabinet Mountains (Joslin 1980) of Montana. Although no permanent roads will be constructed for timber removal along the RMF, timber harvest in Occupied yearlong mountain goat habitat is strongly discouraged and is clearly not in the best interest of maintaining healthy mountain goat populations.

Fire History and Management

The Lewis and Clark National Forest currently operates under a 1984 Fire Management Action Plan. Distribution of natural fires and area burned is depicted in Figure 53 and Table 15, respectively. Although the Birch-Badger segment encompasses more total burned area, the Teton-Dupuyer segment has more burned area within Occupied yearlong mountain goat habitat. Approximately 21 percent of the study area has burned since 1935. Seventy percent of that occurred in Occupied yearlong habitat, primarily in the Teton-Dupuyer segment.

Recent prescribed fires have been burned in Box Creek (0.4 km^2) and Whiterock Creek (grass fire of about 0.2 km^2). A prescribed fire in Hannon Gulch did not burn to specifications, and a 4.0 km^2 burn in Hall Creek is planned.

Although burning as been useful in stimulating forage production within mountain goat habitat in Washington (Olmsted 1979), Smith (1986) in Alaska indicates that old growth timber is highly selected by mountain goats within their home range during winter. In the comparatively arid climate of Montana, prescribed burning in mountain goat habitat has not been shown to be of value. Slow vegetation recovery and possible damage to shallow alpine/subalpine soils may occur with resulting detrimental consequences for mountain goats. Prescribed burning within the fragile subalpine ecosystem is not recommended without careful attention to the needs of mountain goats.

Hunting

Mountain goat hunting seasons in Montana began in 1872 when the territorial legislature banned hunting from February 1 to August 15 of each year. In 1895 the legislature created a Board of Game Commissioners who established an annual mountain goat bag limit of 8. The hunting season at that time was from September 15 to December 31. The bag limit was reduced to 1 goat in 1905. By 1935 a statewide closure on mountain goat hunting was in effect. Not until 1955 was a season on mountain goats along the Rocky Mountain Front reestablished, but this time it was controlled through a permit system (Table 16).

Table 15. Occurrence of natural fires within each type of mountain goat habitat in each study segment of the Rocky Mountain Front.

	BIRCH - BADGER				TETON - DUPUYER				DEEP - SUN				TOTAL			
FIRE AGE	1[1/]	2	3	Tot	1	2	3	Tot	1	2	3	TOT	1	2	3	TOT
50+ yrs old (256.5 km²)	46.7	16.7	92.1	155.5	37.9	---	12.9	50.8	37.1	---	13.1	50.2	121.7	16.7	118.0	256.4
50-25 yrs (20.2 km²)	---	---	---	---	13.2	---	4.3	17.5	1.5	---	1.3	2.8	14.6	---	5.6	20.2
25yrs. old (0.5 km²)	---	---	---	---	0.6	---	---	.6	---	---	---	---	.6	---	---	.6
TOTAL (277.2 km²)	46.7	16.7	92.1	155.5	51.7	---	17.2	68.9	38.6	---	14.4	53.0	136.9	16.7	123.6	277.2

[1/] 1 = Occupied yearlong habitat, 2 = suitable low occupancy habitat, 3 = transitional habitat.

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Table 16. Mountain goat harvest on the Rocky Mountain Front, 1955-1985.

Year	Hunting District	No. Permits	Season Dates	Harvest Male	Harvest Female	Harvest Total
1955	313[1]	5	9/15-11/15			) 4
	314[2]	5	9/15-11/15			)
1956	314[3]	20	9/15-11/15			15
1957	414	20	9/15-11/24			12
1958	414[4]	40	9/15-11/30			21
1959	414[4]	40	9/15-11/22			19
1960	414	60	9/15-11/20			40
1961	414	80	9/15-11/19			45
1962	414	80	10/ 7-11/25			55
1963	414	80	9/15-11/24			46
1964	414	80	10/18-11/22			48
1965	414	80	9/15-11/22			41
1966	414	80	9/15-11/27			31
1967	414	80	9/15-11/26			43
1968	414	100	9/15-12/15			45
1969	414[5]	100	9/15-12/14	25	16	41
1970	414[5]	75	9/15-11/29	15	14	29
	415[6]	50	9/15-12/14	15	11	26
1971	414	50	9/15-11/28	10	1	11
	415	50	9/15-11/28	8	5	13
1972	414	25	9/15-11/26	2	0	2
	415	50	9/15-11/26	10	4	14
1973	414	10	9/15-11/25	2	0	2
	415	25	9/15-11/25	4	2	6
1974	414	No season				
	415	10	9/15-11/24	1	0	1
1975	414	No season				
	415	5	9/15-11/23	3	0	3
1976	414	No season				
	415	5	9/15-11/28			0
1977	414	No season				
	415	5	9/15-11/27	2	2	4
1978	414	5	9/15-11/26	1	1	2
	415	10	9/15-11/26	1	1	2
1979	414	5	9/15-11/25	1	3	4
	415	10	9/15-11/25	4	0	4
1980	414	5	9/15-11/30	1	3	4
	415	5	9/15-11/30	0	2	2
1981	414	5	9/15-11/29	2	1	3
	415	5	9/15-11/29	1	2	3
1982	414	5	9/15-11/28	4	2	6
	415	5	9/15-11/28	1	2	3
1983	414	5	9/15-11/27	1	3	4
	415	3[7]	9/15-11/27	1	0	1
1984	414	5	9/15-11/25	1	1	2
	415	3	9/15-11/25	2	1	3
1985	414	5	9/15-12/1	2	0	2
	415	3	9/15-12/1	0	1	1

1 - Hunting district (HD) 313=Route Cr, M Fk Teton south, including Lewis & Clark National Forest in Teton Co.

2 - HD 314=north of 313 in Lewis & Clark National Forest to Birch Cr

3 - Teton County within Lewis & Clark National Forest

4 - HD 414=open to Highway 2 on national forest land east of Continental Divide

5 - HD 414=south & east of Teton Pass down Trail 114 to road then east to national forest boundary then north to Birch Creek then west up trail 121 along the N Fk Birch Cr to its head at Continental Divide then south along divide to Teton Pass

6 - HD 415=north of HD 414 to Highway 2

7 - One hunter could not be contacted to determine whether he had harvested a goat

Over the years hunting district boundaries and numbers of permits fluctuated throughout the state in response to demand, and wildlife management philosophies which advocated harvest pressure to stimulate herd production (Figure 54). Management of the Rocky Mountain Front population reflected mountain goat management throughout the state (Figure 55), but in both cases the desired population response was not achieved and eventually permits were reduced to accommodate decreasing herds.

A more conservative management approach toward mountain goats has emerged and so has the need for determining the status, trend and distribution of individual population segments. On the Rocky Mountain Front at least 4 relatively autonomous populations have been identified (see Population Distribution).

Physical differences between female (left) and male (right) mountain goats are subtle. Hunters are encouraged to select males (MDFG photo).

Population information for the Teton-Dupuyer segment indicates that the 5 permits which are currently allowed in HD 414 and the 3 permits in HD 415 fall within the range of 4 percent (Kuck 1977), which is used in Idaho, 5 percent (Hall 1977) used in Alberta, and 7 percent (Adams and Bailey 1982) used in Colorado. The estimated mountain goat population is 122 for HD 414 and 96 for HD 415. Ballard (1977) indicates that 10 percent of the observed number of mountain goats is used to establish permit levels in Alaska, however this method was developed for heavily timbered country and would be liberal for the Rocky Mountain Front.

That portion of the Rocky Mountain Front mountain goat herd which is not hunted, particularly the Deep Creek-Sun River segment, has demonstrated a vulnerability to people in the past. Although this herd may be slowly increasing since transplanting and hunting ceased 10 years ago, its distribution has been altered and its ability to provide recreational opportunities has been severely limited. New pressures in the form of energy exploration and development, livestock grazing or other human activities could once again retard or reverse population growth.

Reducing hunting seasons is not an equitable or acceptable method of compensating for impacts created by other human activities. If the management guidelines developed for the Rocky Mountain Front are rigorously followed, and mountain goat herds still decline, then hunting seasons or permits must be reduced.

Establishment of conscientious hunting seasons requires knowledge of a herd's natural mortality, productivity and recruitment as well as hunter wounding losses, percentage of permit holders who participate in the hunt, hunter success, and a hunter education program. Beginning in 1985, all mountain goat hunters received a brochure entitled Choosing a Trophy Mountain Goat, which was designed to help mountain goat observers distinguish between males and females, adults and juveniles, and urges hunters to avoid harvesting females. Management of game animals theoretically strives to limit hunter take to equal the net annual gain in population. If other human activities are taking a toll on population numbers through mortality, decreased productivity or habitat alteration, then they too must be taken into account when hunting seasons are established. Proliferating road access is the primary problem which wildlife managers face when developments encroach into mountain goat country. The kind and degree of effect a road may have on a particular goat herd must be determined. In the past, mountain goats probably suffered less from poaching than most other species since road access into goat terrain was limited. Now that roads are penetrating their habitat, goats may be more prone to poaching losses since their structured, predictable behavior dictates use of traditional areas regardless of the presence of a road.

MANAGEMENT RECOMMENDATIONS

The goal of the Rocky Mountain Front mountain goat investigation is to ensure the continued survival of a healthy, viable mountain goat population from the Sun River to Badger Creek while industrial activities and recreation take place in the same country. The Rocky Mountain Front Interagency Committee was in part established to pursue this goal. The committee consists of representatives from the Lewis and Clark National Forest, Bureau of Land Management, U. S. Fish and Wildlife Service, and the Montana Department of Fish, Wildlife and Parks. In April 1984 and 1986 the Committee endorsed the Rocky Mountain Front Wildlife Guidelines (Appendix 17) which provide management direction for human activities in mountain goat habitat as well as in grizzly bear, raptor, elk, mule deer and bighorn sheep habitat.

The recommendations provided here are the culmination of 6 years of study on the Rocky Mountain Front mountain goat population. These recommendations reiterate and augment the endorsed mountain goat guidelines.

Mountain Goat Seasonal Use Areas

Criteria used in delineating seasonal use areas are described in Results under Seasonal Distribution. The terms Occupied, Suitable and Transitional habitat describe specific areas within which human activities are managed under guidelines tailored to maintain the habitat requirements of mountain goats in that area. These guidelines include timing of use and certain activity restrictions. The area from the Sun River north along the North Fork Sun and Continental Divide to the Badger-Two Medicine Divide then south along the prairie-reef zone at the east edge of the Rocky Mountain Front is defined by a heavy black line which delineates mountain goat habitat. The relative use of this area by mountain goats is indicated by areas identified as Occupied yearlong habitat (number 1), Suitable low occupancy habitat (number 2) and Transitional Habitat (number 3) in Figures 37 through 50. Occupied yearlong habitat is the heart of mountain goat habitat on the RMF. It is used yearlong by mountain goats and contains all known kidding-nursery areas and breeding areas. Suitable low occupancy habitat possesses all the environmental features of Occupied habitat, but mountain goats have not been observed in these areas. Transitional habitat, by virtue of its juxtaposition with Occupied and Suitable areas, is used by goats primarily for travel, although some mineral licks do occur there. Mountain goat seasonal habitat delineations should be incorporated into the data base of the Lewis and Clark National Forest for use in Forest planning.

Kidding-Nursery

Those areas in which a lone adult female was recorded during May or June, and those areas in which a kid of the year was observed

during June, July, or August constitute known kidding-nursery areas. These areas are identified with a dotted line in Figures 32 through 50. Descriptions of environmental features used by mountain goats meeting the above criteria were discussed previously (see Seasonal Distribution, Kidding-Nursery Areas). In all cases, known kidding-nursery areas occur in Occupied yearlong habitat. Timing restrictions for human activities in kidding-nursery areas occur from May 1 to July 15.

Breeding

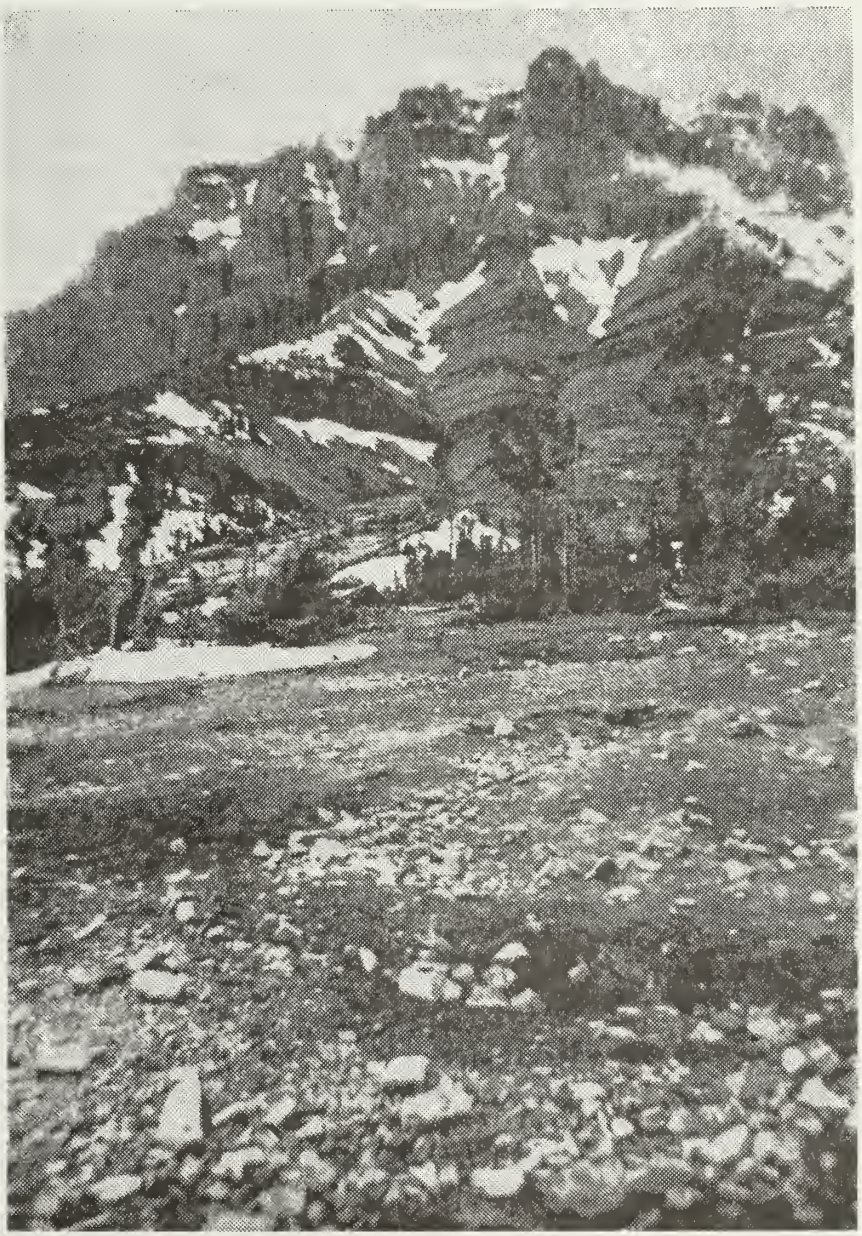
Those areas known to be used by adult mountain goats during the November-December breeding period are identified with a dashed line in Figures 32 through 50. Descriptions of environmental features used by mountain goats at this time were discussed previously (see Seasonal Distribution, Breeding Areas). In all cases, known breeding areas occur in Occupied yearlong habitat. Timing restrictions for breeding areas occur from November 1 to December 31. Areas confirmed to be used by mountain goats during both breeding and kidding-nursery periods are identified with an alternating dot-dash line in Figures 32 through 50.

Mineral Licks

Seventeen identified mineral licks occur within Rocky Mountain Front mountain goat habitat. Thirteen of these occur in Occupied yearlong habitat (Figures 32 through 50), 3 occur in Transitional habitat and one falls outside the mountain goat habitat boundary. Mineral licks within mountain goat habitat are more than simply a location where goats congregate to lick salt; they are important physiographic features which influence home range size and configuration of each goat using the area. The Blackleaf mineral lick, for example, influenced the movements and home ranges of all 34 marked mountain goats in the Teton-Dupuyer segment. All human activities near mineral licks within mountain goat range should be carefully managed since damage, alteration, or disturbance to the site could have deleterious effects on a number of mountain goats by altering movement patterns and home ranges as well as preventing necessary sodium intake. Since mineral licks can entice mountain goats into vulnerable situations, establishing new mineral licks within mountain goat habitat should be done only after determining whether the proposed lick site would make mountain goats vulnerable to people or predators and whether its placement would pull livestock into areas of goat use during phenologically sensitive periods (May and June). The following guidelines are recommended for management of mineral licks:

1) a no surface occupancy stipulation should be placed on energy and mineral exploration and development and timber harvest within a 0.8 km (0.5 mi) radius of mineral licks,
2) new mineral licks within mountain goat habitat should not be established without carefully considering the safety of goats,

3) limit livestock use of mineral licks to after July 1, or stagger allotment use so that adjacent licks are not used simultaneously by livestock,
4) establish helicopter flight paths at least 1.6 km (1 mi) from mineral licks during the May 1-July 31 period,
5) restrict use of roads and trails which come to within 0.8 km (0.5 mi) of a lick to nonmotorized use during the May 1 to July 31 period, and
6) the road crossing the Blackleaf lick should be closed or relocated 0.8 km (0.5 mi) to the east on Volcano Reef.



The Blackleaf mineral lick influences the movements and home ranges of at least 40 percent of all mountain goats in the Teton-Dupuyer segment of the Rocky Mountain Front (photo by Gayle Joslin).

Occupied Yearlong Habitat

Occupied yearlong habitat (number 1) is vitally important to the well-being of mountain goat herds along the Rocky Mountain Front. Mountain goats have been observed in these areas over the years during winter and/or summer. Environmental features used by mountain goats during summer and winter were discussed previously (see Seasonal Distribution, Summer and Winter Areas) and do not differ significantly from season to season. Therefore, areas in which goats were observed during summer were considered winter use areas as well, and vice versa. Particularly during mild years, mountain goats appear to travel their range almost as extensively as during summer. Since mountain goats use number 1 areas yearlong, the following guidelines are recommended:

1) restrict activities in winter range from October 15 to May 15,
2) obliterate and reclaim existing roads where access cannot be effectively controlled,
3) limit seismic operations to methods which can be accomplished in the least amount of time and with minimal disturbance - the 9 mile line spacing should be strictly enforced (see discussion below),
4) maintain helicopter flight distances at a minimum of 300 m (980 ft) from all ground surfaces (canyon walls included),
5) restrict helicopter flight paths to corridors of maximum 0.8 km (0.5 mi) or less in width,
6) landtypes typical of occupied habitat are generally poor timber producers, timber harvest should not be allowed;
7) restrict livestock grazing to the period from July 1 to October 15,
8) do not use heavy equipment for fire suppression, if access is created to control fire, reclaim all roads and trails,
9) wildlife habitat manipulation should not occur unless a program satisfactory to the needs of all species whose habitat is involved is endorsed by the Montana Department of Fish, Wildlife and Parks, and
10) emphasize nonmotorized recreation.

Items 4) and 5) differ from the Interagency Management Guidelines in that minimum flight heights have been raised from 200 m to 300 m based on literature concerning aircraft harassment to wildlife (see Human Activities - Oil and Gas Exploration).

Particular care should be taken not to disrupt or prevent use of the travel corridors across the North Fork, South Fork and main Badger creeks, which connect isolated areas of Occupied mountain goat habitat, to the main mass of mountain goat habitat in the Birch-Badger segment. Specific efforts must be made to maintain minimum helicopter flight heights over these travel corridors at all times of the year.

The 9 mile spacing restriction between seismic lines should be modified to eliminate all energy exploration related activity within the quiet zone, ie. no survey crews should be allowed to work between seismic lines. Allowing seismic crews to work between lines was a recommendation developed in the Cumulative Impact Recommendations of the Environmental Assessment on Geophysical Exploration on Nonwilderness Lands (1982). To allow such activity completely defeats the purpose of the spacing restriction, as does the cumulative effects recommendation which allows concurrent seismic activity if the lines are closely spaced. The rationale for these recommendations was that exploration activity would be expedited in an area, and thus completed more quickly if a company could work on several lines at once. However, since timing restrictions do not exist regarding shooting of consecutive lines, the next company waiting for access to the area move in immediately and begins seismic work. The Cumulative Effects recommendations actually serves to magnify the intensity of human activity within an area, thus creating ever greater cumulative effects. Items 3 and 6 should be deleted from the Cumulative Effects Recommendations as they now appear in the LCNFP (1986).

Suitable Low Occupancy Habitat

Suitable low occupancy habitat (number 2) has all of the physical characteristics of Occupied yearlong habitat and is probably important mountain goat habitat, but observations of goats have not been recorded in these areas. Surveys of suitable mountain goat habitat must be made to determine whether goats are present prior to initiation of a planned activity. If goat use is documented, the stratification will be changed to Occupied yearlong mountain goat habitat and the listed guidelines will apply. If mountain goat use is not documented, then guidelines listed for Transitional habitat will apply.

Transitional Habitat

Transitional habitat (number 3) is used by mountain goats primarily during peak movement periods such as spring and fall, but compared to Occupied or Suitable habitat, it does not generally provide the environmental characteristics which goats seek. Terrain typical of Transitional habitat generally has slope inclinations of less than 70 percent and/or elevations of less than 1830 m (6000 ft). Landtypes on Transitional habitat usually have more soil accumulation and greater vegetation growth potential than those of Occupied or Suitable habitat. Creeks typically flow through the center of Transitional habitat. The following guidelines are recommended for management of Transitional habitat:

1) limit timber harvest, road construction, oil and gas or hard rock mineral exploration and development, to the period July 1 to October 15 and January 1 to April 30 (exclusive of spring transition and breeding movements), and
2) restrict helicopter flight paths to water courses.

Human Activities

To achieve the desired mitigative effect, recommendations for specific human activities must be reviewed in conjunction with those for mountain goat seasonal use areas.

The pace and extent of human activities along the Rocky Mountain Front promises to increase. If the downward trend in the RMF mountain goat population is to be halted, then improved to 1981 levels, 4 concepts pertaining to human impacts should be reviewed to reinforce the importance of conscientiously implementing these management guidelines. First, each human activity will have an effect upon the land and the wildlife which inhabit it. As activities are superimposed, their effects become synergistic, and each new activity or increase in activity level is more detrimental than an individual activity. Second, although the system may appear to be in balance, various human activities may be subtly depressing a herd. This may be occurring in the Deep-Sun segment where the mountain goat herd has been low for over 15 years, despite a closed hunting season. Third, although a relatively small area may experience direct impacts from energy exploration, livestock grazing, timber harvest or other activity, a significant portion of the population which uses that area may be affected. For example, the Blackleaf mineral lick probably constitutes less than 0.1 percent of the home range of the mountain goats which use it, but at least 30 percent of the entire Teton-Dupuyer population would be affected if that site were disturbed. Finally, since mountain goats are extremely methodical in the use of their range and are reluctant to move or change their habits, exposure to human activities are likely to be manifest internally where the field biologist cannot readily document the effects of that exposure except through long-term monitoring of population dynamics

Oil and Gas Exploration

The activity of helicopters and seismic crews are likely more disturbing than seismic blasts, although mountain goats would often startle and run when blasts occurred. Wildlife will panic at the approach of helicopters (McCourt et al. 1974, Miller and Gunn 1979, Klein 1973, Calef et al. 1976, Irwin and Gillin 1985, Foster and Rahs 1985), and mountain goats have been observed falling from cliffs when approached by helicopters (Joslin 1980). Recommendations to confine and reduce the intense level of exploration activity involve:

1) establish helicopter flight paths and enforce strict adherence to a corridor 0.8 km (0.5 mi) or less in width (corridors should follow water courses in Transitional habitat when possible),
2) require helicopters to maintain distances of 300 m (980 ft) from all ground surfaces,
3) consolidate the number of helicopter trips to complete each line,
4) space concurrently active seismic lines at 14.5 km (9 mi) intervals to provide an undisturbed corridor into which mountain goats can move when displaced,
5) no human activity should occur within the undisturbed corridor between active lines (including survey crews),
6) the Lewis and Clark National Forest's environmental assessment on oil and gas leasing on nonwilderness lands should be amended to include current information and recommendations concerning mountain goats.

Energy development, because it is an extended, intense activity (pipelines, powerlines, roads, drill pads, settling basins, collection facilities), should not occur within Occupied and Suitable mountain goat habitat. If it occurs within Transitional habitat, recommendations to minimize impacts upon mountain goat habitat should be followed.

Increased mountain goat populations in the particularly depressed Mount Pablo-Half Dome Crag, Running Owl Mtn.-Elk Calf Mtn., and Deep Creek-Sun River areas are contingent upon minimizing population depressants: primarily seismic exploration, exploratory drilling, and hunting. Currently little or no hunting occurs in these 3 areas, so management responsibility revolves around carefully controlling energy exploration. Strict adherence to these management guidelines is essential.

Vehicle Access

Since proliferation of road access has led to mountain goat declines in Montana, British Columbia, Idaho, Alberta, Washington and Alaska, it is recommended that roads and other facilities such as pipelines and powerlines not be constructed in Occupied and Suitable habitat. Recommendations specific to Transitional habitat are provided to reduce the overall effect of roads upon mountain goat habitat on the Rocky Mountain Front. Roads should not be constructed within 0.8 km (0.5 mi) of Occupied and Suitable habitat. Existing roads within this 0.8 km buffer zone which approach known kidding-nursery or breeding areas should be obliterated and rerouted. If it is possible to create an effective road closure (strategically located gates), then seasonal restrictions within Transitional habitat of May 1 to July 15 for kidding-nursery areas and November 1 to December 31 for breeding areas should be enforced. Crucial to the welfare of mountain goats, is immediate reclamation of new roads constructed into Occupied, Suitable, or Transitional habitat, after they have served the purpose for which they were originally built. An

effort should be made to identify all critical wintering areas which snowmobilers should avoid. The Lewis and Clark National Forest Travel Plan should accommodate the needs of mountain goats by incorporating these recommendations when managing roads within mountain goat habitat.

The cliffs of Muddy Creek, which support mountain goats yearlong, are flanked by a new road. Proliferating road access in mountain goat habitat has led to herd declines in several Montana mountain ranges (photo by Gayle Joslin).

Livestock Grazing

When human activities result in displacement of other ungulates, particularly bighorn sheep, this displacement may result in increased competition between other wildlife and mountain goats. It is recommended that actual and potential competition of various wildlife species and livestock be investigated to determine where, when, and to what degree forage or spatial

requirements overlap. AUMs in current grazing and outfitter allotments should not be increased, nor should the number of allotments be increased. In most instances, the number of AUMs using an allotment was below the allocated rate. Since wildlife have adjusted to these levels, the allocated rate should be reduced to current levels to avoid magnifying the cumulative effects of grazing, timber harvest, energy exploration, and road construction upon mountain goats. Domestic sheep are capable of directly competing with mountain goats, therefore, sheep allotments should not be established. AUM levels on many administrative units are above allocated levels. These levels should be reduced to allocated levels.

Concentrated range use by mountain goats and domestic stock occur at mineral licks and can be minimized by implementing guidelines recommended in an earlier section on Mineral Licks.

Timber Harvest

Occupied and Suitable habitats occur on landtypes having little commercial timber potential. Due to the importance of these areas to goats, no timber harvesting should occur in Occupied and Suitable habitat. No particular restrictions in Transitional habitat are recommended unless access would require crossing Occupied or Suitable habitat, or unless kidding-nursery and breeding areas occur at the edge of Transitional habitat, in which case a 0.8 km (0.5 mi) buffer zone along the boundary must be accommodated.

Fire Management

Heavy equipment should not be used in mountain goat habitat to suppress fires; but if emergency access is built into mountain goat habitat to fight fire, then all roads and trails should be reclaimed immediately after control activities have ceased.

The generally open nature of mountain goat habitat on the Rocky Mountain Front is not conducive to habitat improvement through burning; nor has it been demonstrated that burning can improve mountain goat habitat on or east of the Continental Divide. For the purposes of habitat manipulation, the use of fire should be limited to Transitional habitat, and then only if it is necessary to benefit habitat for other wildlife species.

Hunting

The established hunting permit levels for the 2 mountain goat hunting districts (414 and 415) along the Rocky Mountain Front occur within the acceptable range of allowable harvest. Hunting seasons should be established contingent on extensive early summer annual mountain goat surveys of these districts because: 1) a severe winter could seriously reduce the population, 2)

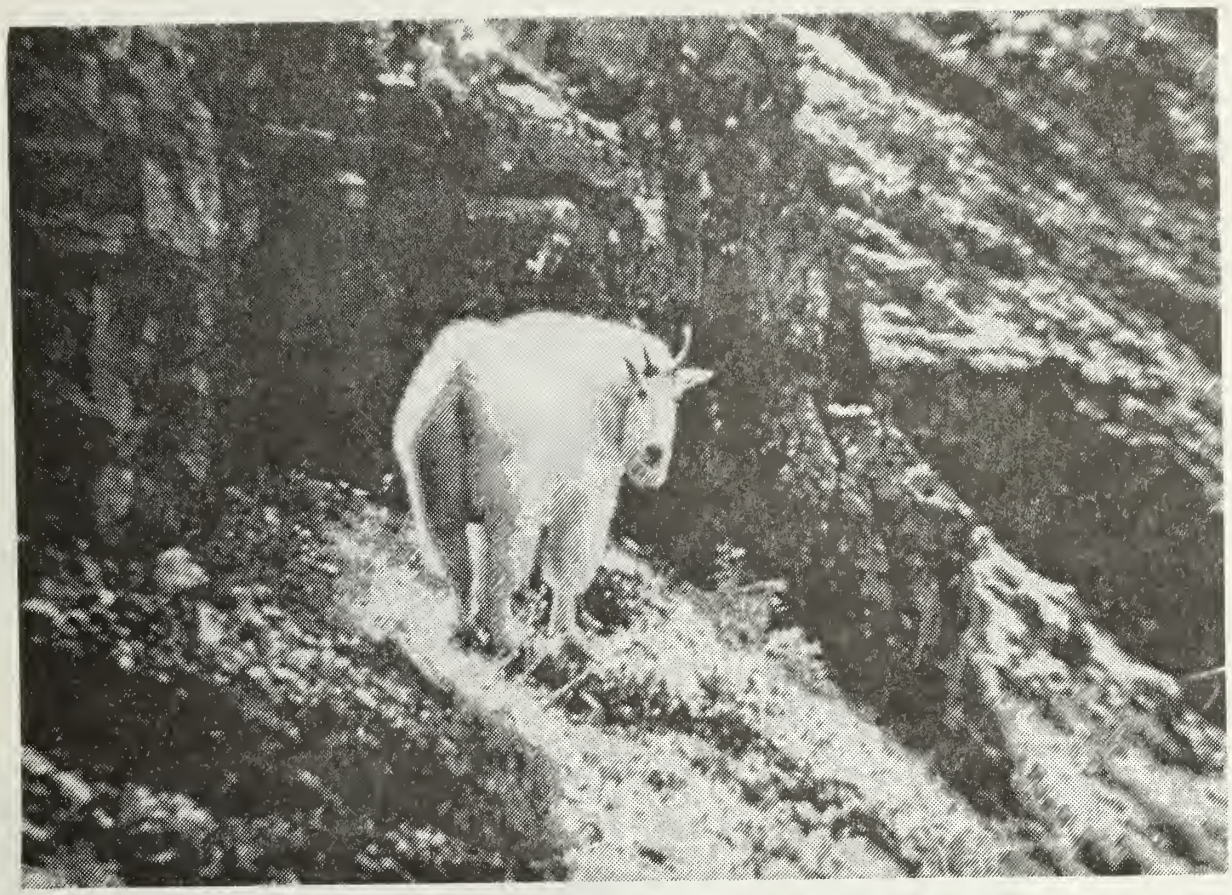
human impacts could be affecting mountain goat distribution and herd levels which would otherwise go undetected, and 3) the use of hunting statistics alone have proven to be inadequate to properly establish hunting seasons. Since a marked sample may not be present in either hunting district, the number of permits should be based on not more than 5 percent of the actual number of goats observed during early summer surveys.

Refinement of hunting district boundaries would more adequately distribute the hunting pressure. The area north of main Badger Creek involving the Mount Pablo-Mount Baldy-Kiyo Crag- Half Dome Crag complex and that portion of the Continental Divide north of Bullshoe Mountain should be excluded from hunting district 415. The Choteau Mtn. - Mt. Werner area should be eliminated from HD 414 to reduce the harvest of females, and the female harvest in both districts should be carefully monitored. No more than one female should be taken from each HD annually. Hunting district 414 could be divided along the South Fork Birch Creek, and another hunting district created between the South Fork and North Fork, to redistribute hunting pressure into Birch Creek.

In order to understand how hunting affects the Rocky Mountain Front mountain goat population, it is important to obtain as much hunting-related information as possible within each hunting district. All mountain goat hunters should be contacted before the hunting season to advise them of current hunting regulations which requires that the head of their harvested goat be submitted to MDFWP representative within 10 days of the kill, and to encourage harvest of male rather than female goats. Mountain goat identification brochures should continue to be mailed out each year to permit holders. At the close of the hunting season, all hunters should once again be contacted to record their success, when and where they hunted, and where and how many goats they observed. This information will help identify: 1) hunter distribution and areas which are receiving excessive hunting pressure, 2) actual harvest rates and sex ratios, 3) age structure of harvested goats, 4) wounding losses, and 5) mountain goat distribution during the hunting season.

Reducing hunting seasons is not an equitable or acceptable method of compensating for impacts created by other human activities. If the management guidelines developed for the Rocky Mountain Front are rigorously followed, and mountain goat herds still decline, then both the guidelines and hunting seasons must be re-evaluated.

An important aspect of mountain goat work along the Rocky Mountain Front is not only to provide maps of detailed range use by mountain goats and provide recommendations to avoid

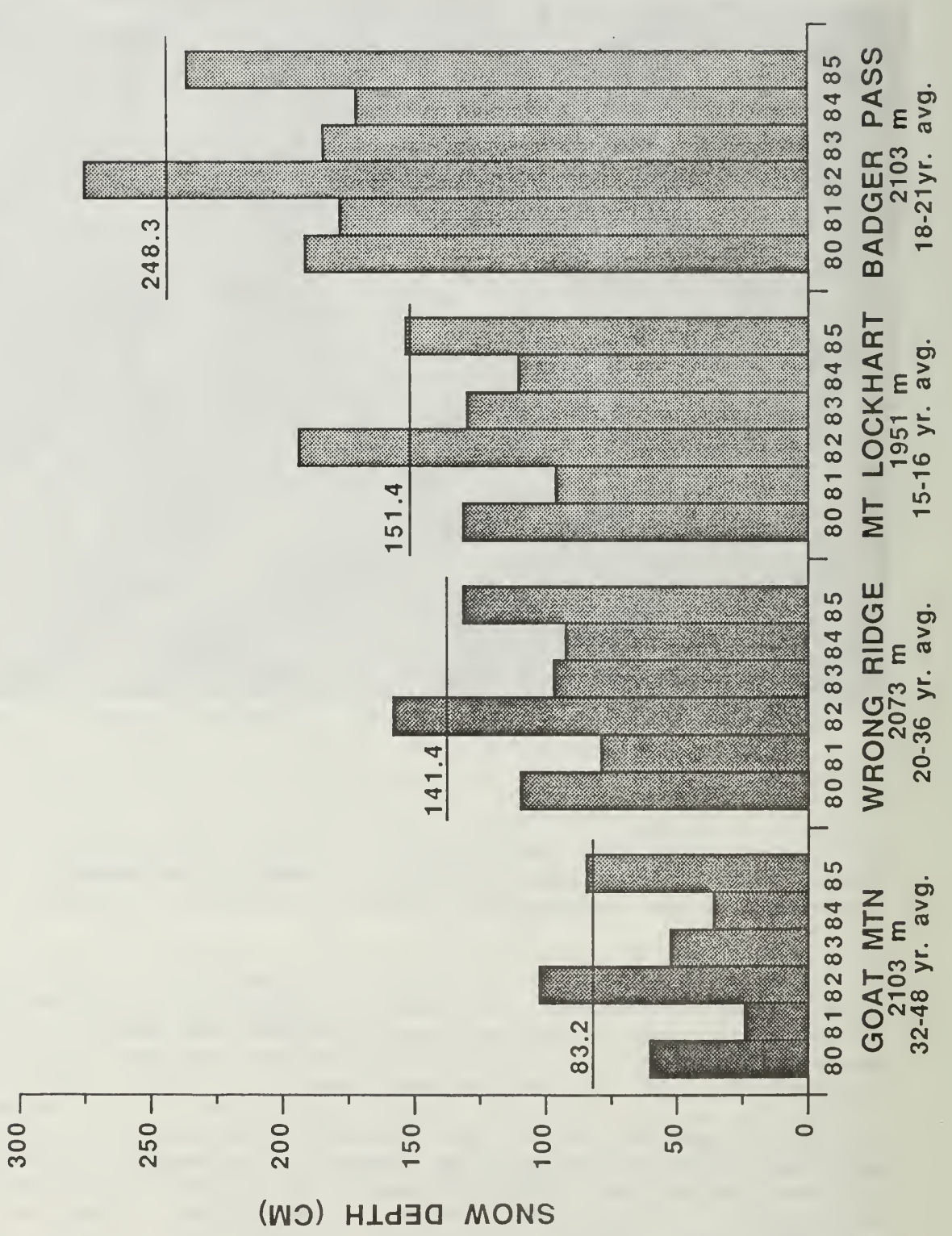


To ensure healthy populations of mountain goats, and yet accommodate human activities, strict adherance to the recommendations presented here is essential (Forest Service photo).

unnecessary conflict, but also to monitor mountain goats as developments take place to determine whether the recommendations are functioning to avoid or minimize impacts. It may be determined that the recommendations are either inadequate, or overly restrictive and, in either case, they should be modified. Updating and refining the recommendations will ensure that mountain goats are receiving a level of management concern which corresponds to the level of potential human impact and habitat disruption. Monitoring leads to a better understanding of mountain goat ecology and is a prerequisite to the continued survival of the native population along the Rocky Mountain Front.

805/6

Figure 1. Average snow depths (March, April, May) from four survey sites along the Rocky Mountain Front.



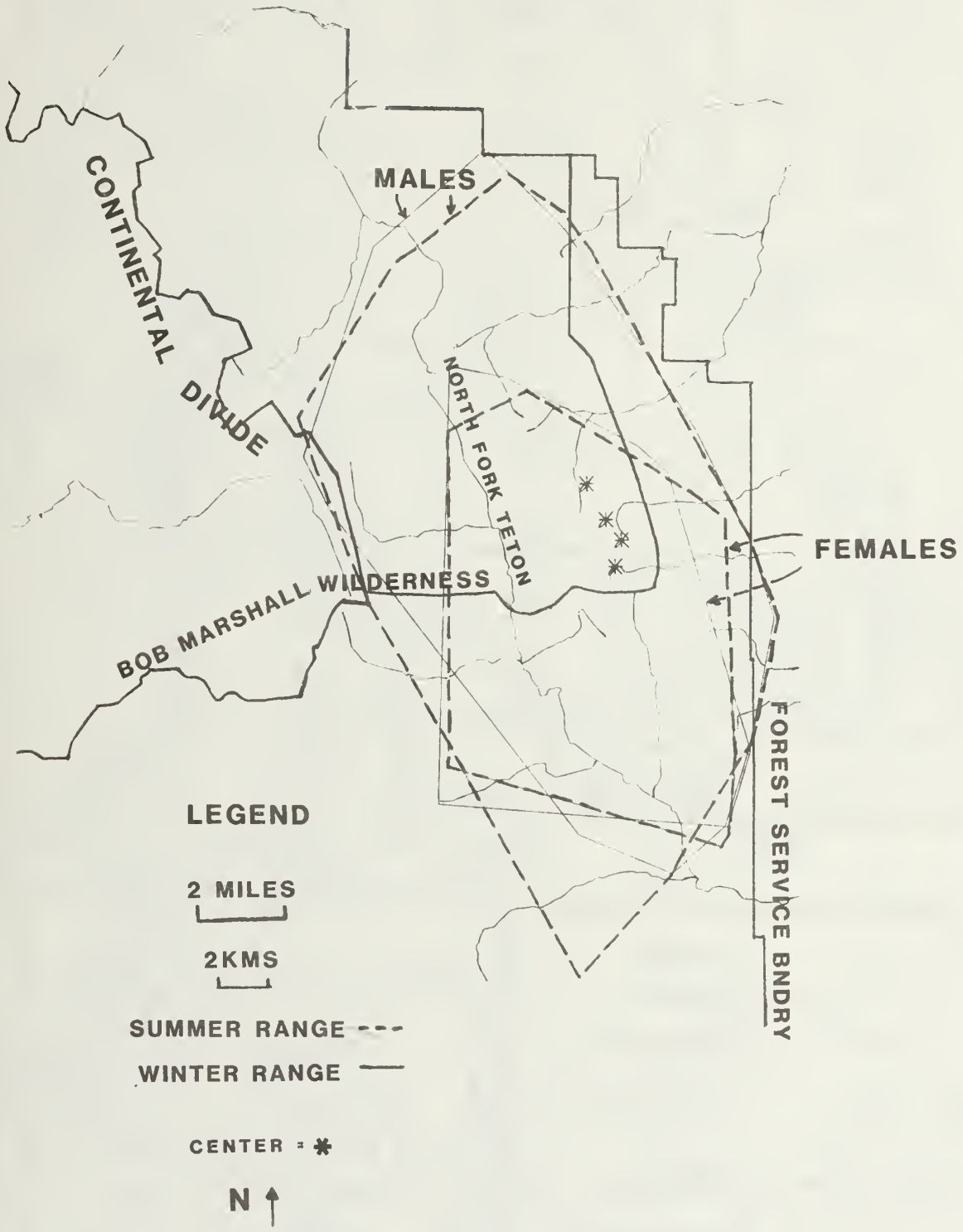


Figure 2. Collective summer and winter home ranges of radio-marked male and female mountain goats on the Rocky Mountain Front.

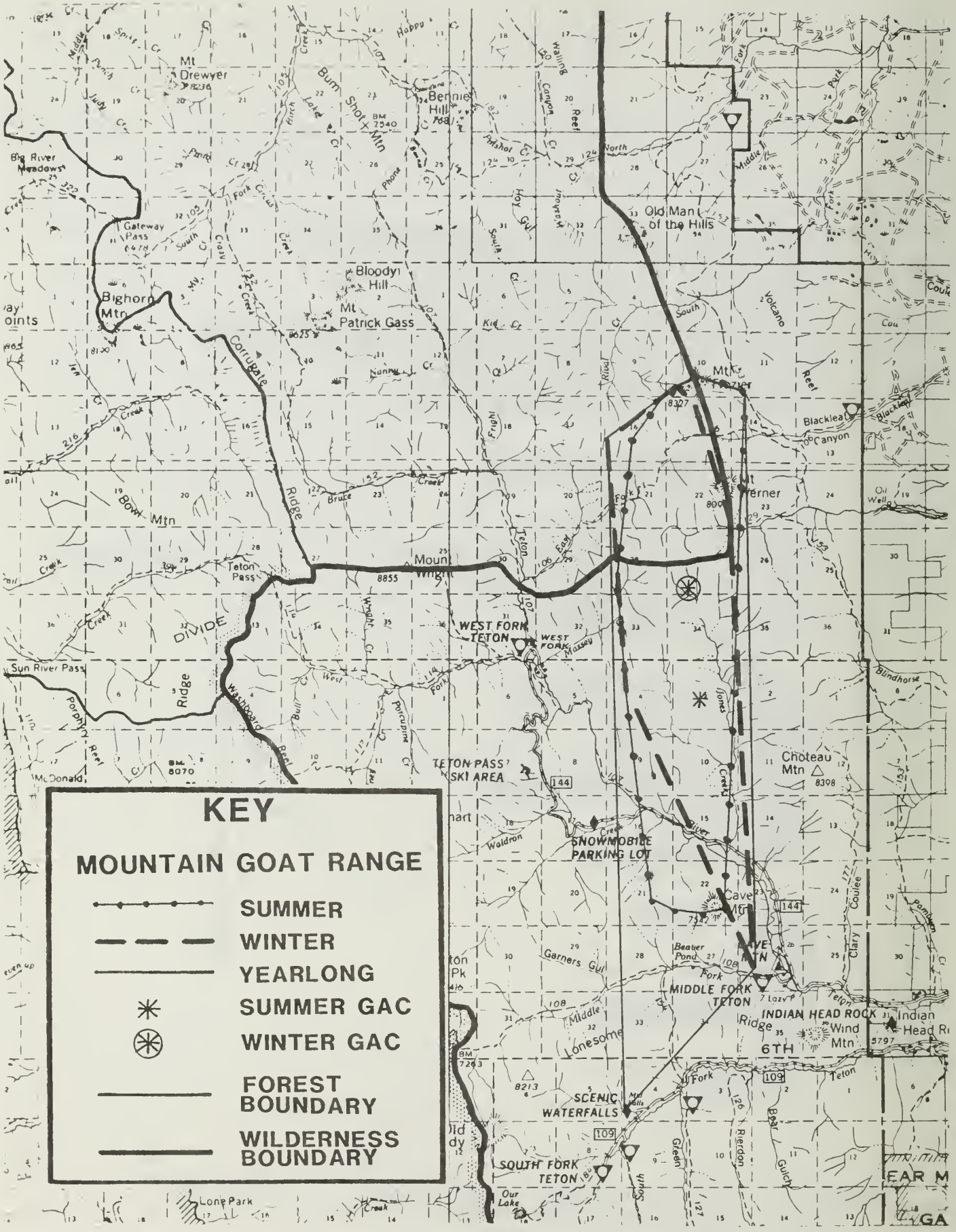


Figure 3. Summer, winter, and yearlong home range and GACs of male mountain goat 7239.

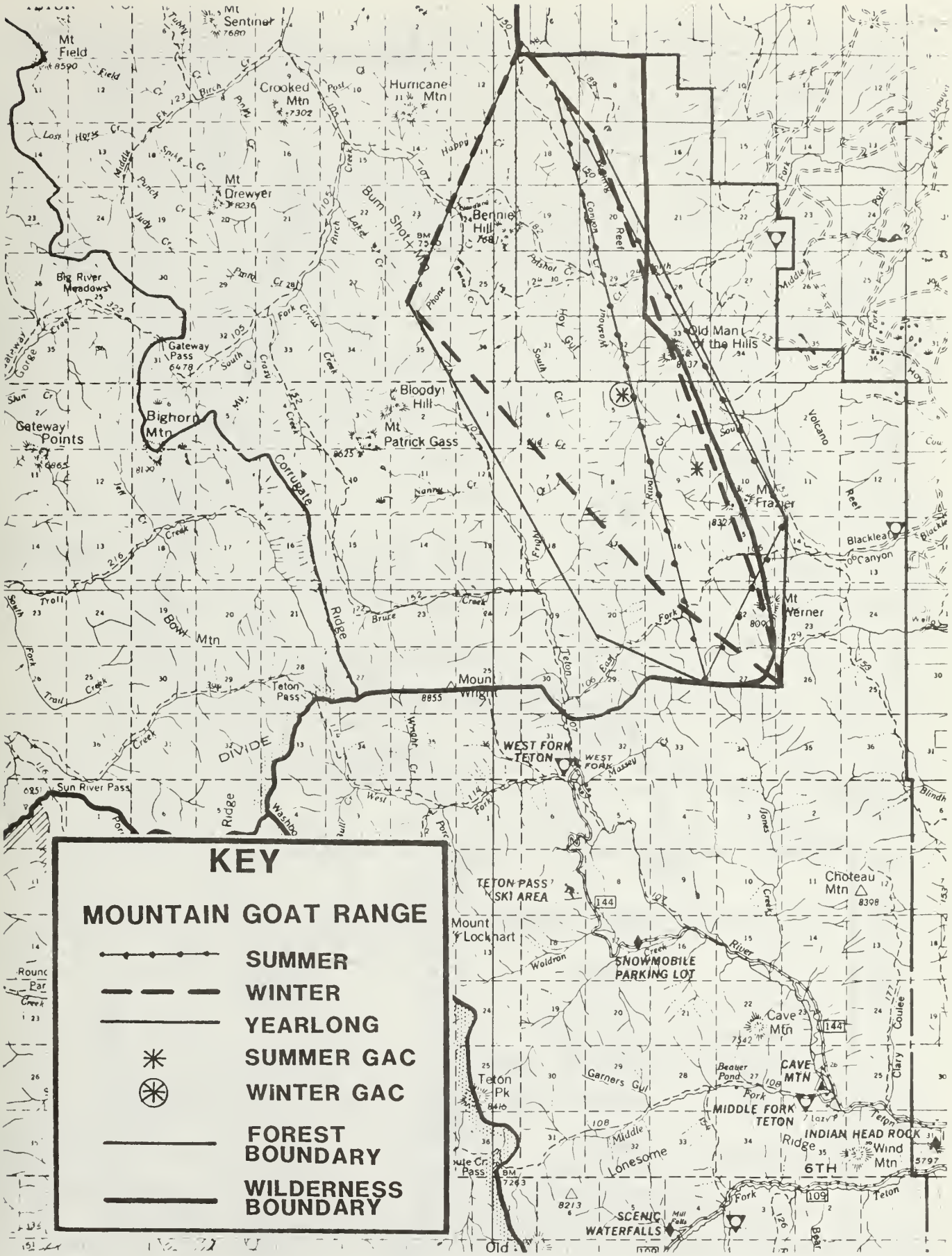


Figure 4. Summer, winter, and yearlong home range and GACs of male mountain goat 7881.

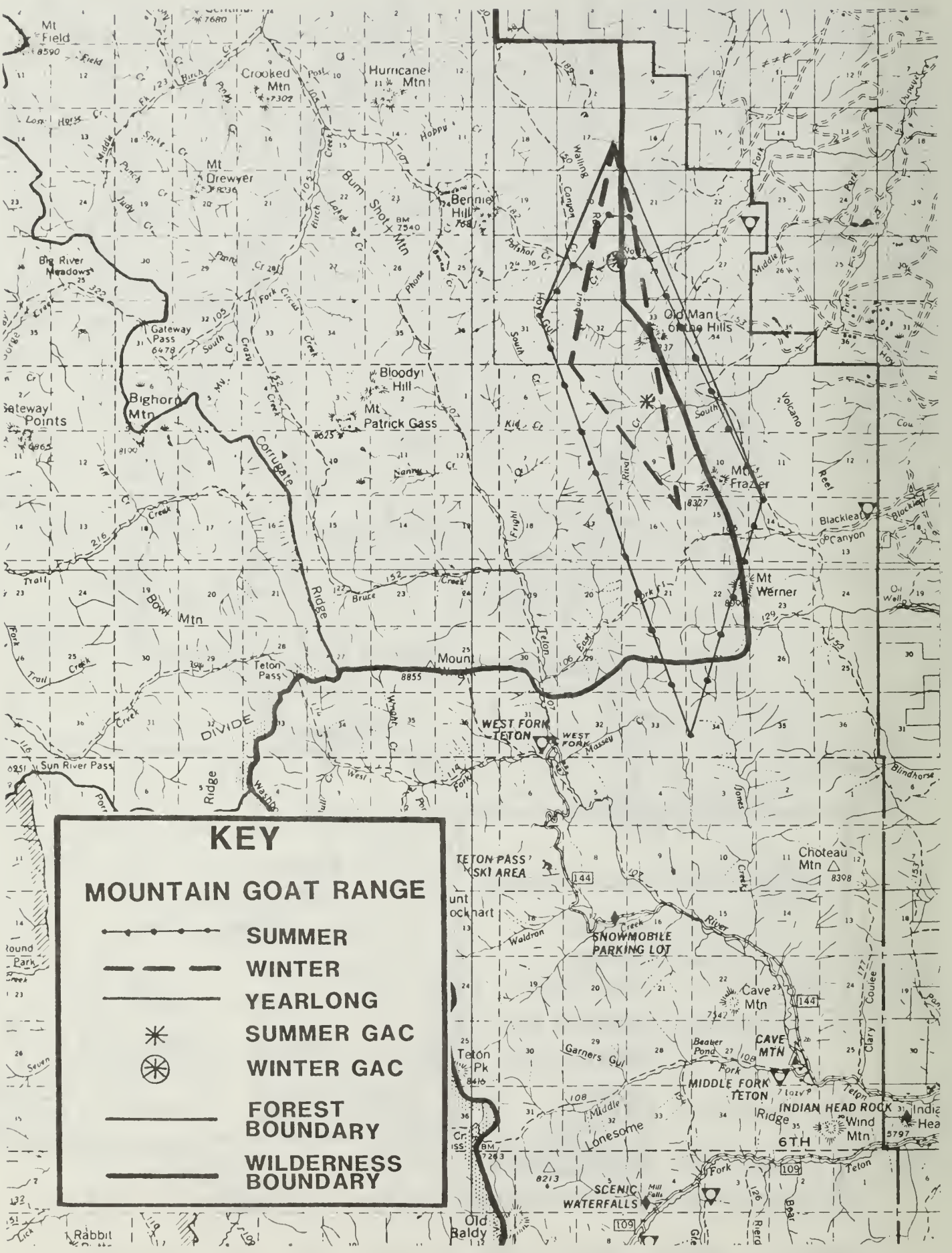


Figure 5. Summer, winter, and yearlong home range and GACs of male mountain goat 0131.

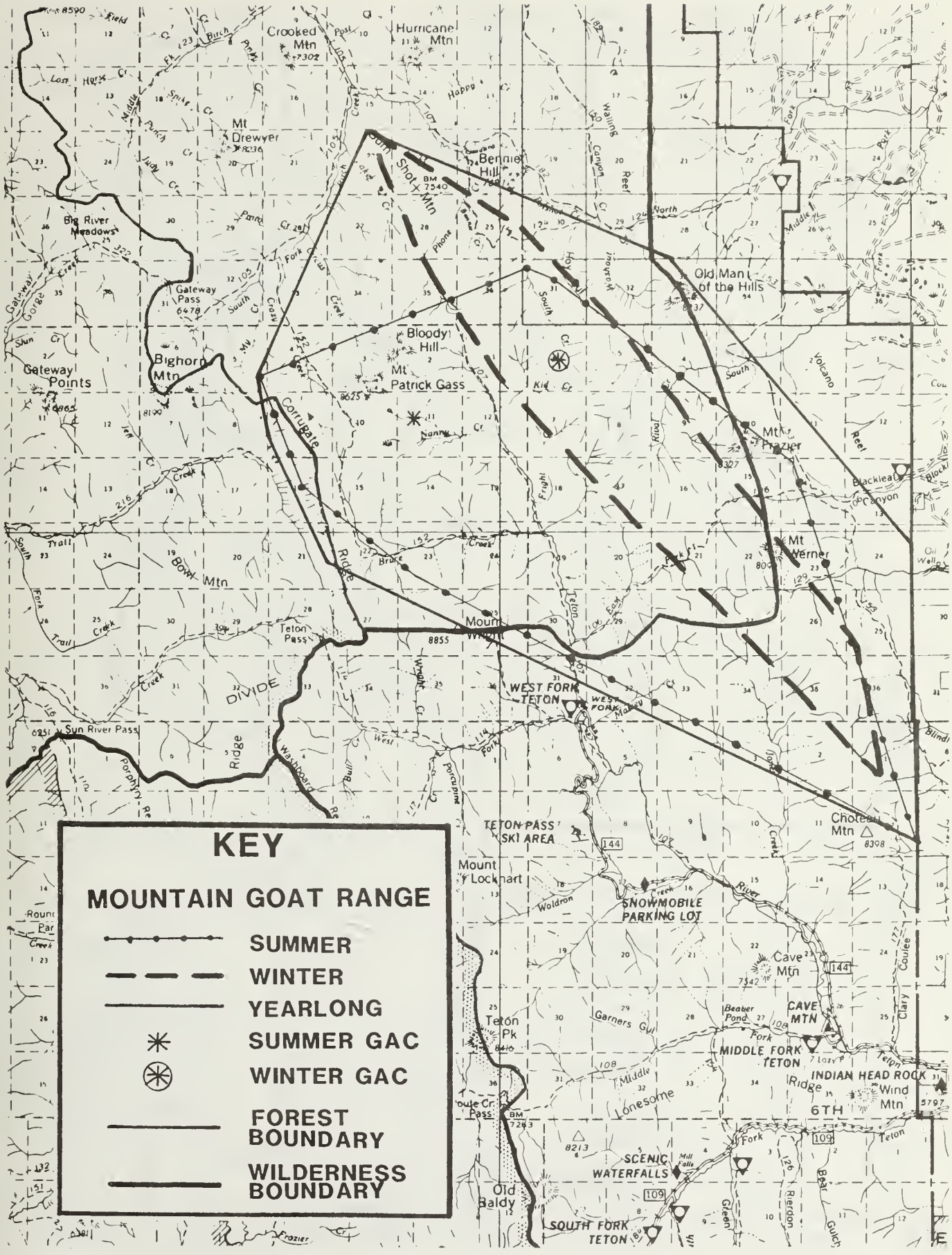


Figure 6. Summer, winter, and yearlong home range and GACs of male mountain goat 6982.

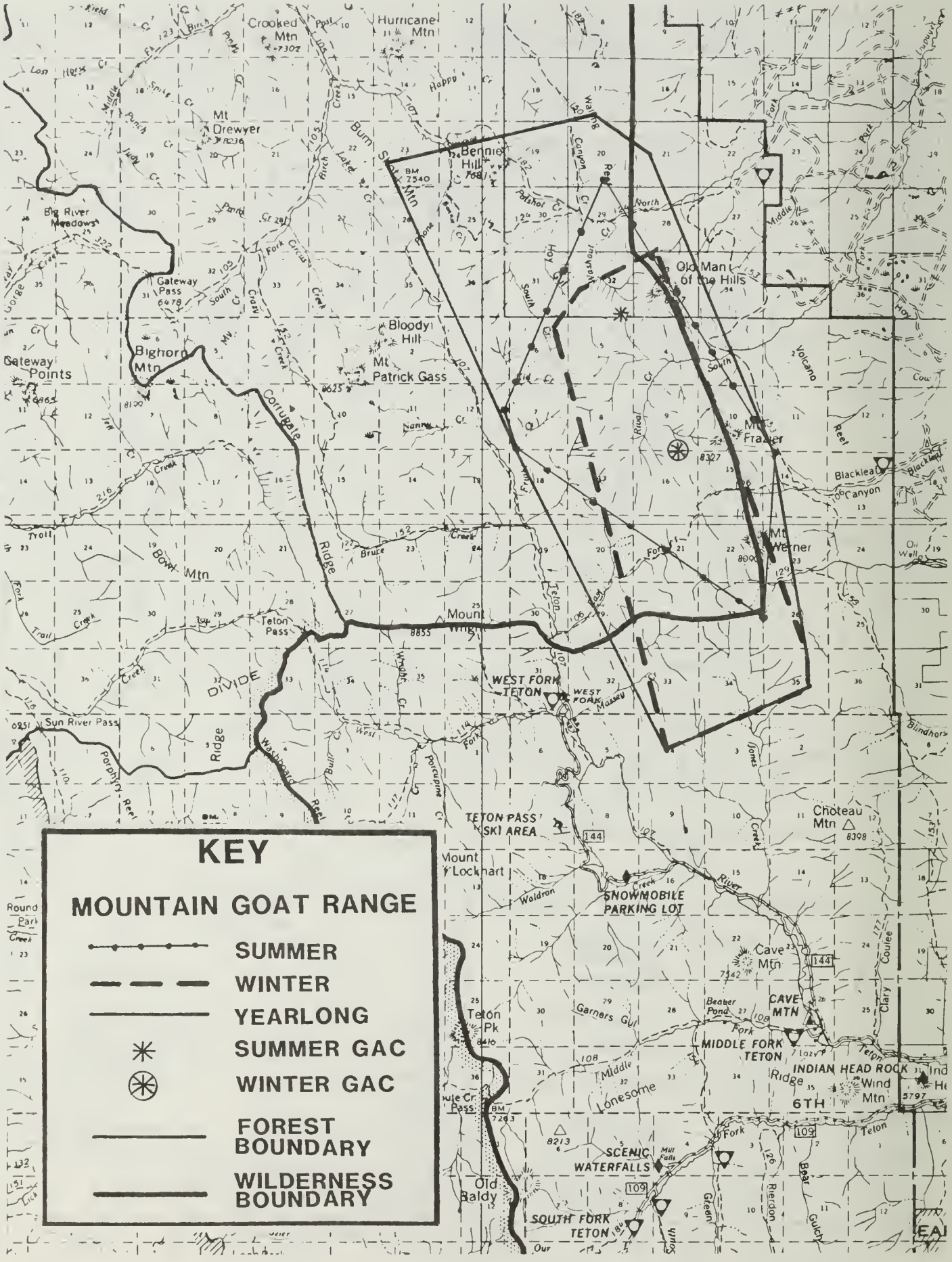


Figure 7. Summer, winter, and yearlong home range and GACs of male mountain goat 7082.

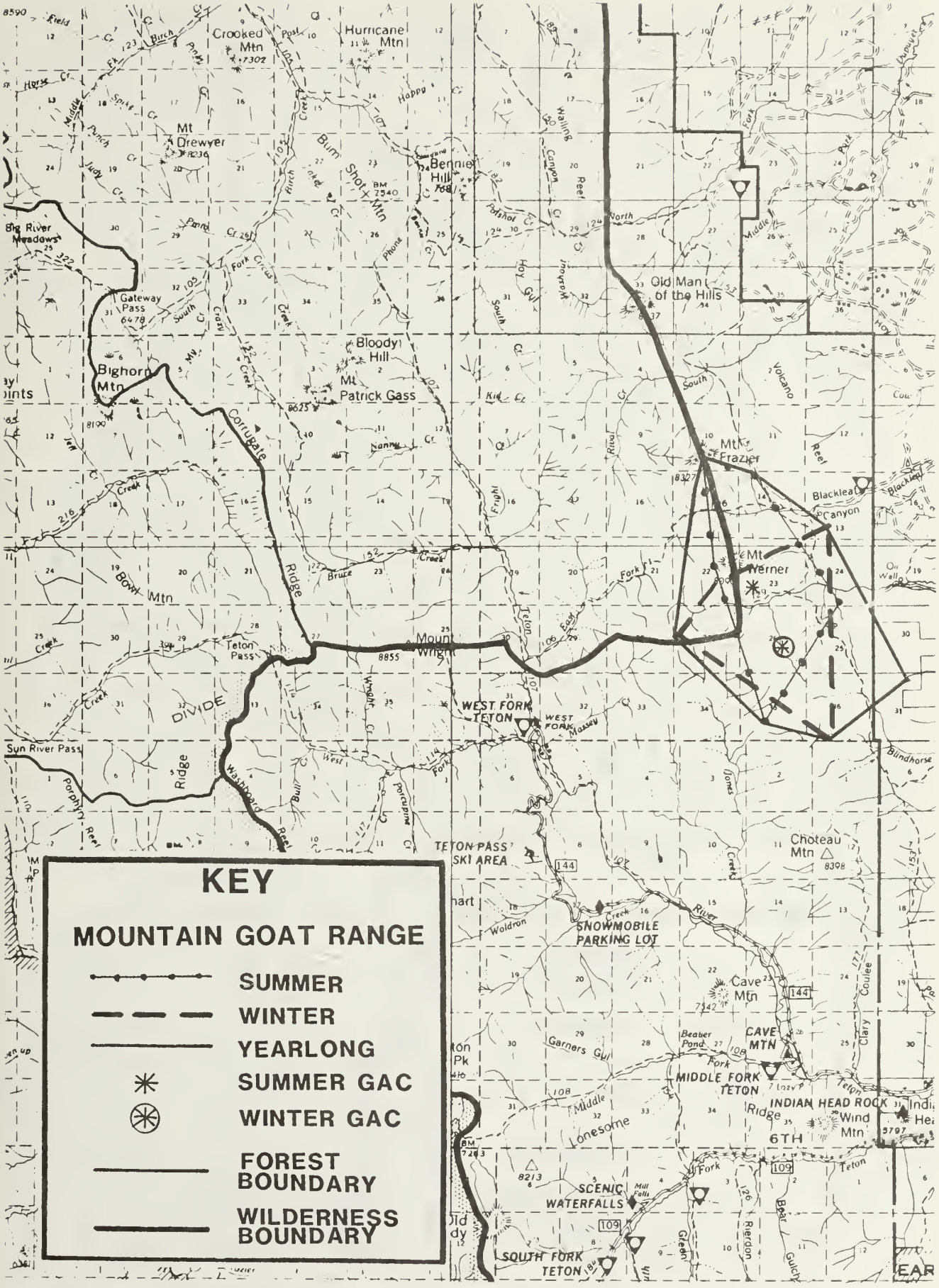


Figure 8. Summer, winter, and yearlong home range and GACs of male mountain goat 2692.

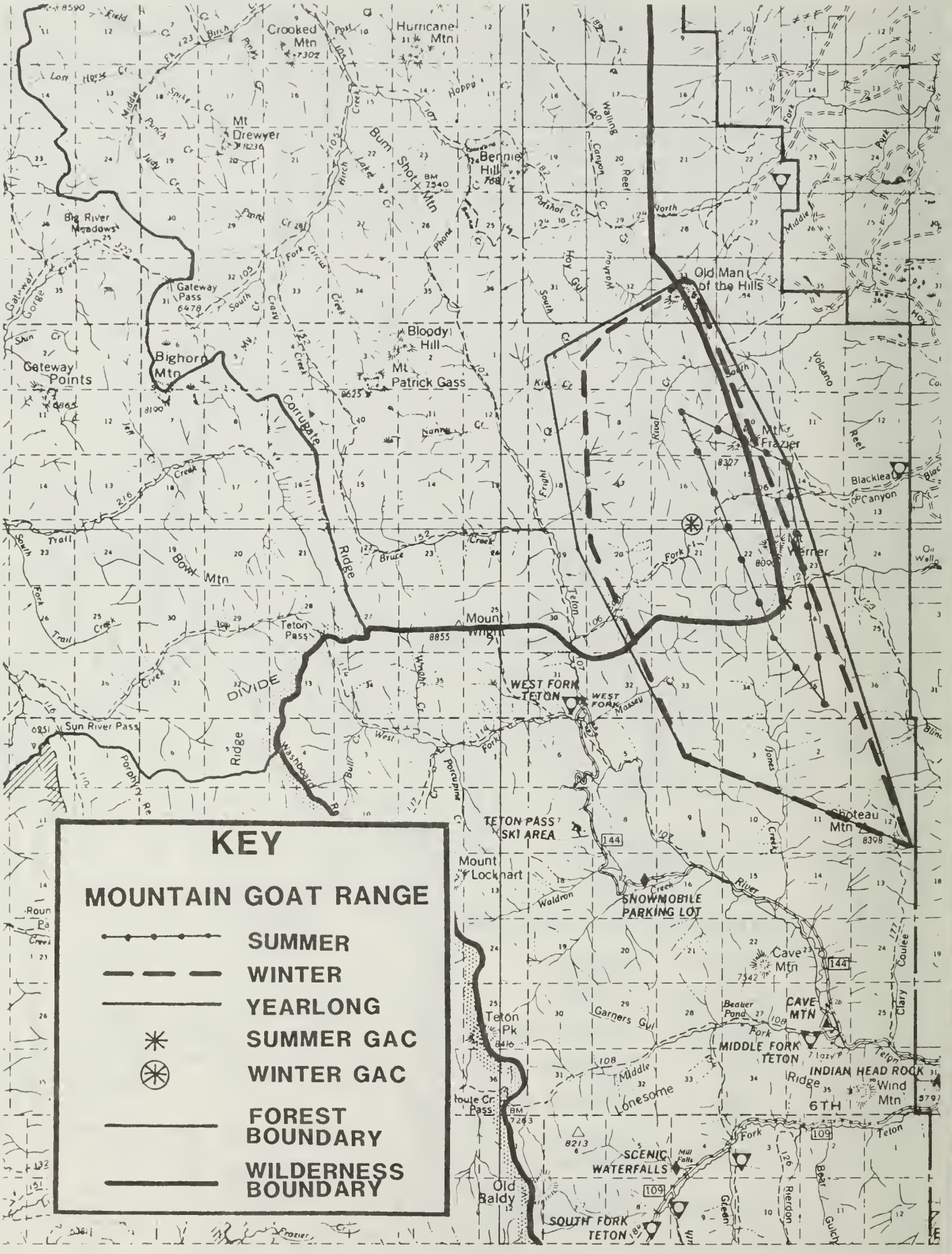


Figure 9. Summer, winter, and yearlong home range and GACs of male mountain goat 1802.

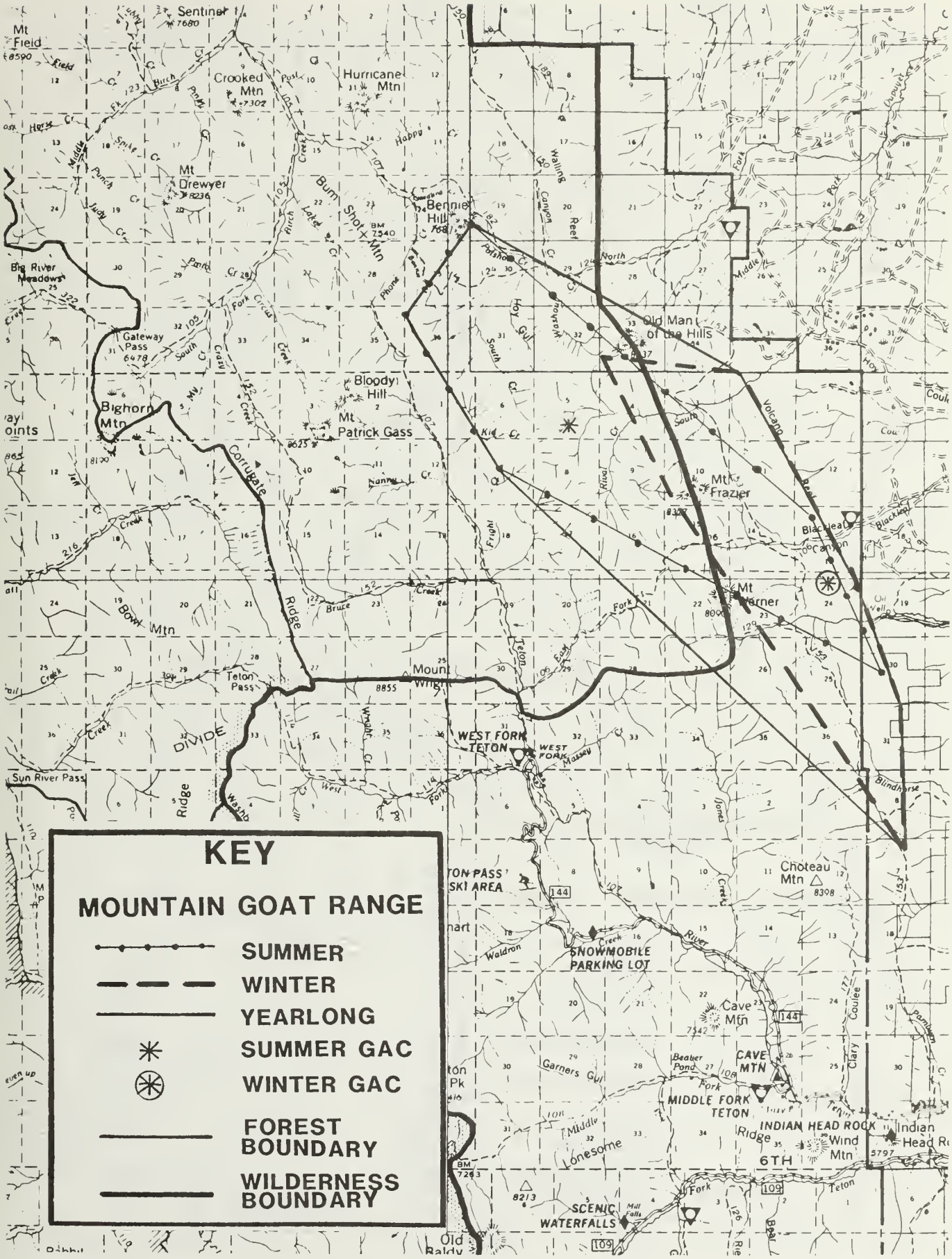


Figure 10. Summer, winter, and yearlong home range and GACs of male mountain goat 8612.

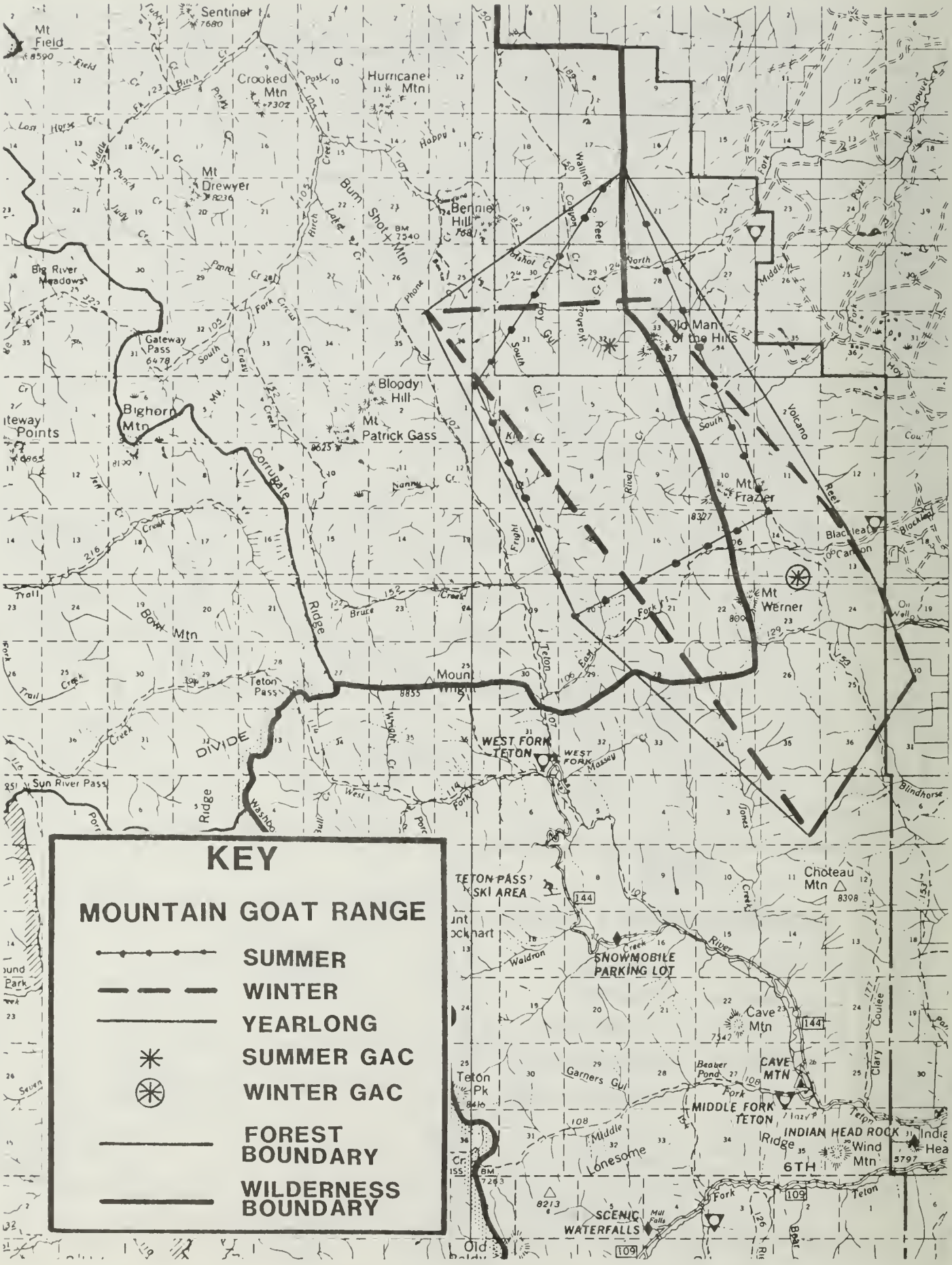


Figure 11. Summer, winter, and yearlong home range and GACs of male mountain goat 3402.

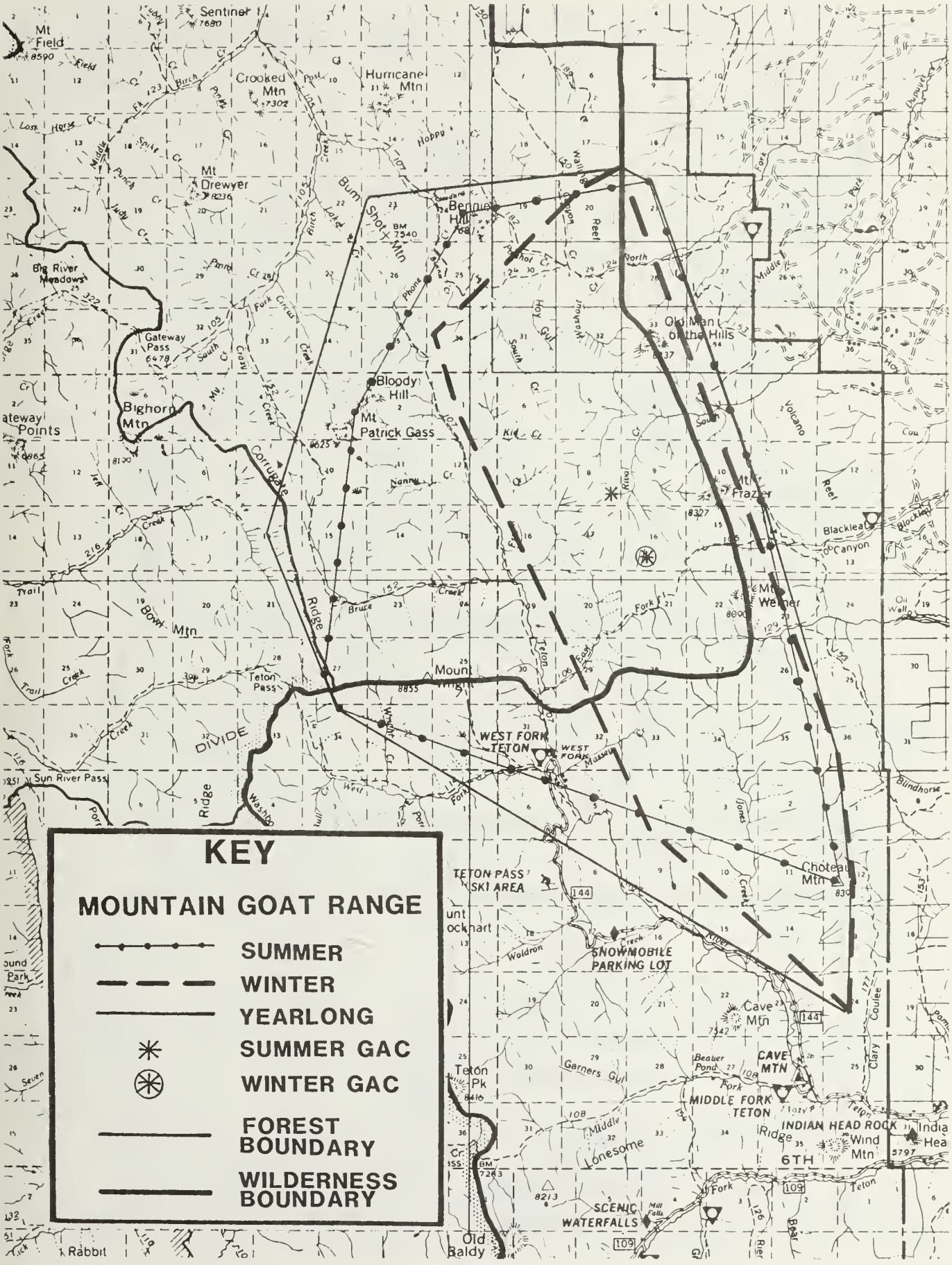


Figure 12. Summer, winter, and yearlong home range and GACs of male mountain goat 1859.

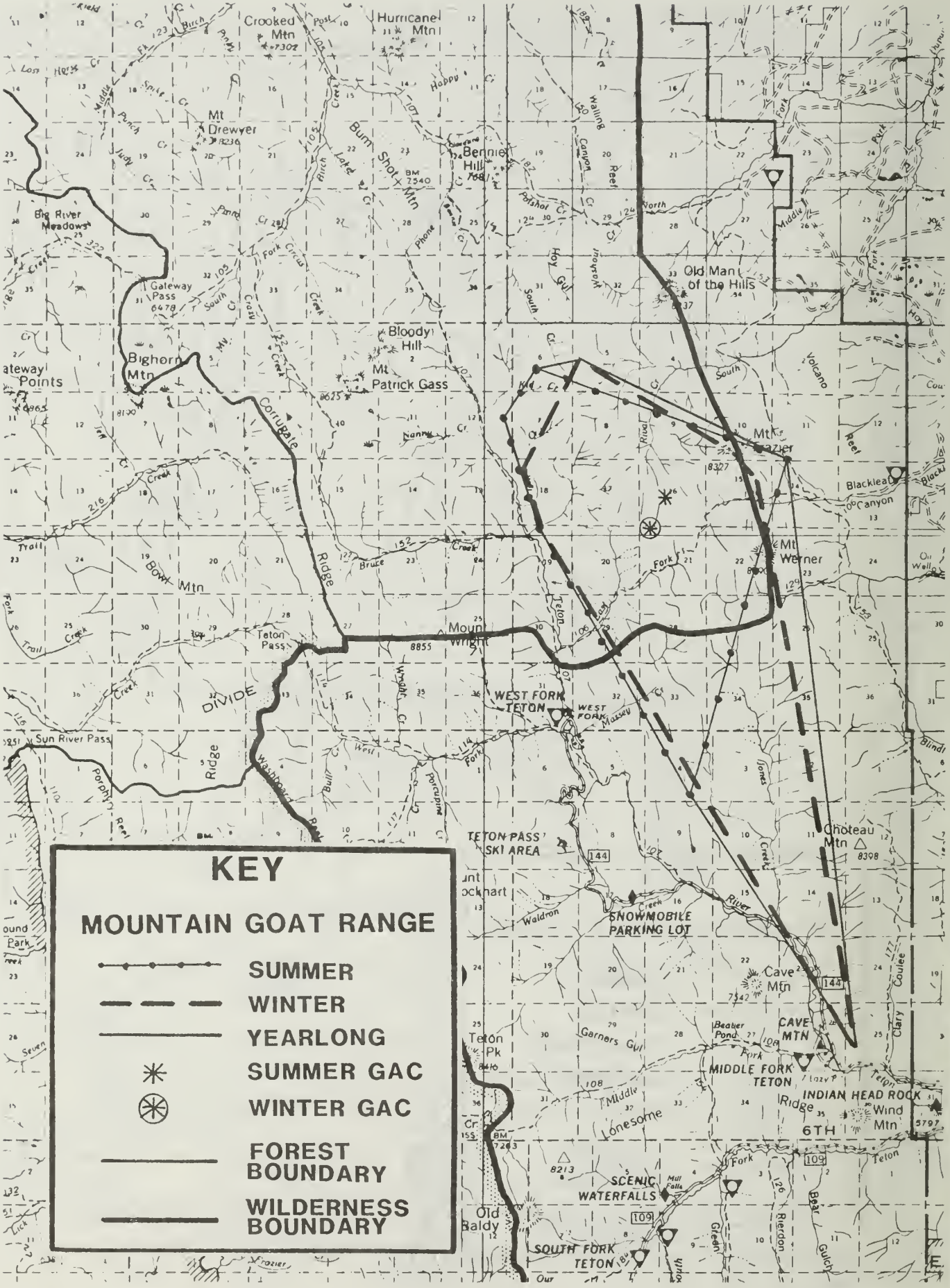


Figure 13. Summer, winter, and yearlong home range and GACs of female mountain goat 829.

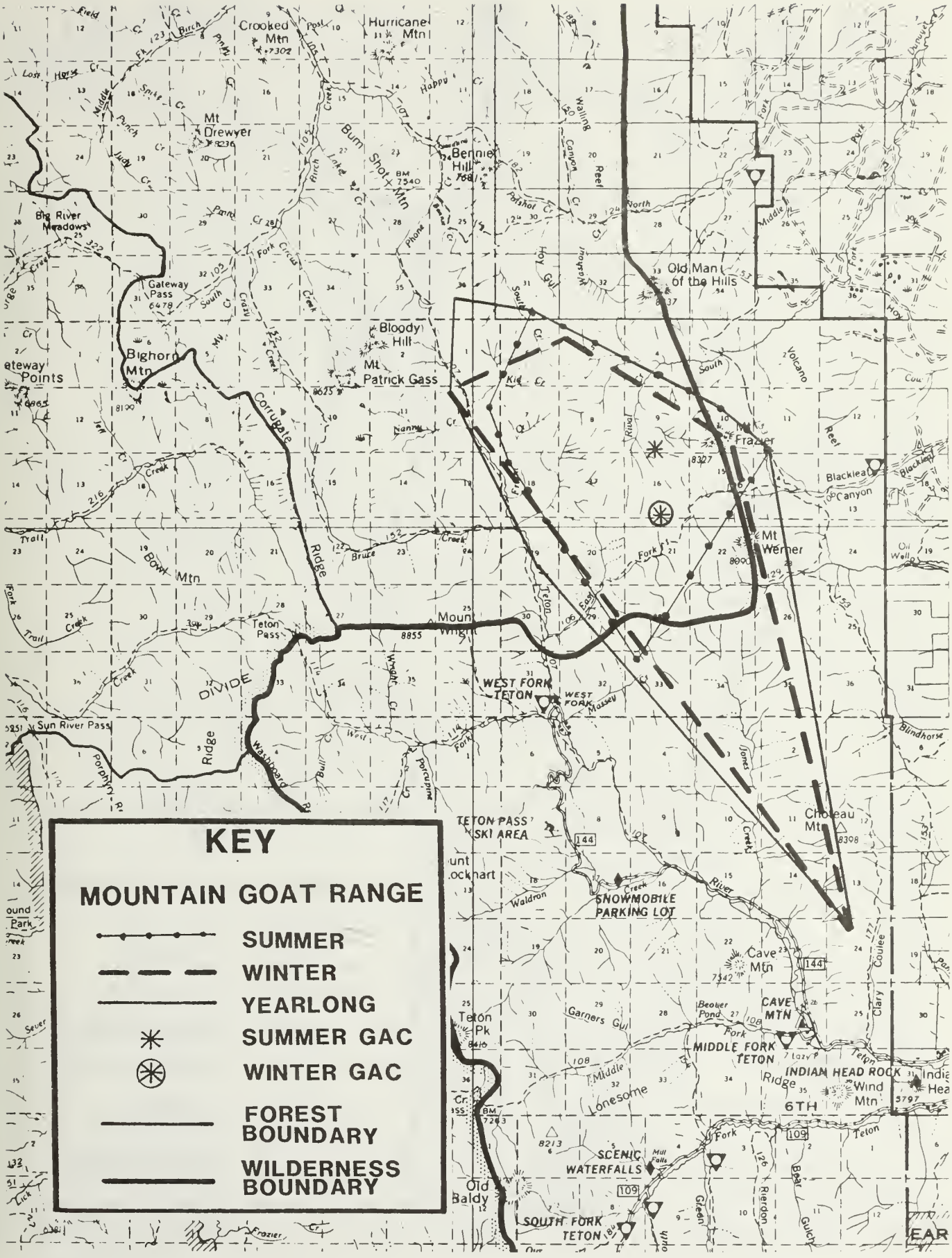


Figure 14. Summer, winter, and yearlong home range and GACs of female mountain goat 1729.

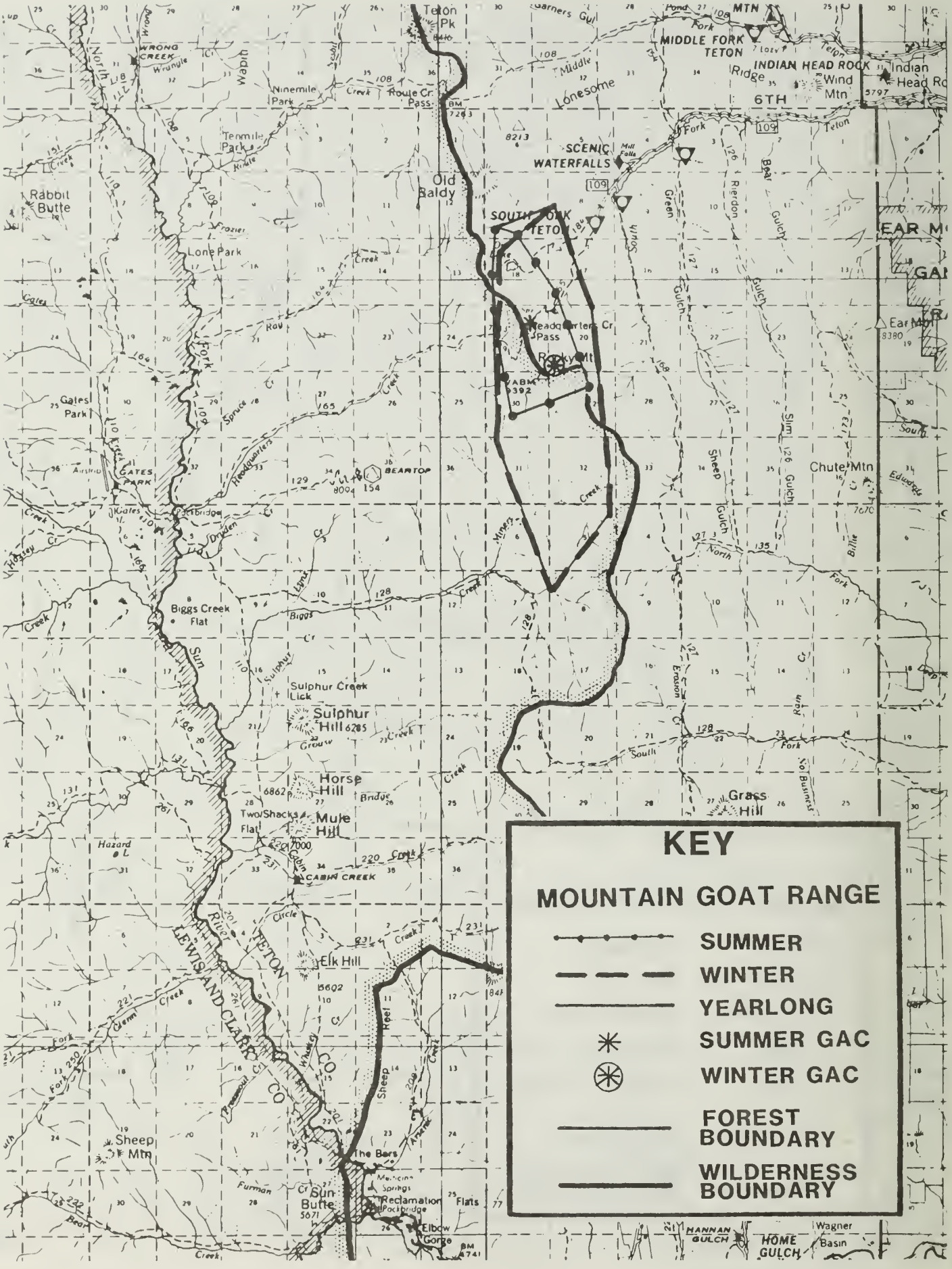


Figure 15. Summer, winter, and yearlong home range and GACs of female mountain goat 2220.

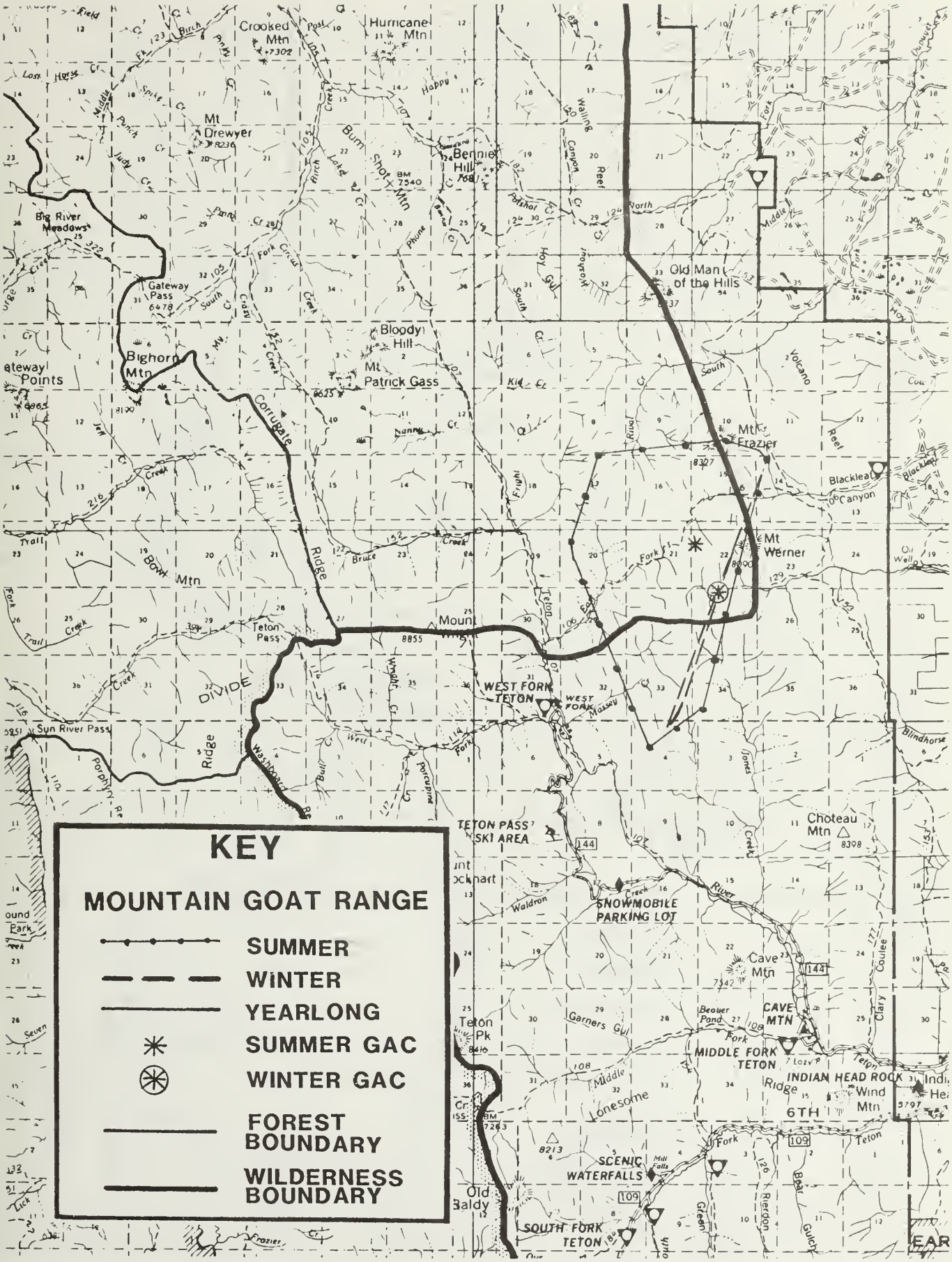


Figure 16. Summer and winter home range and GACs of female mountain goat 8141.

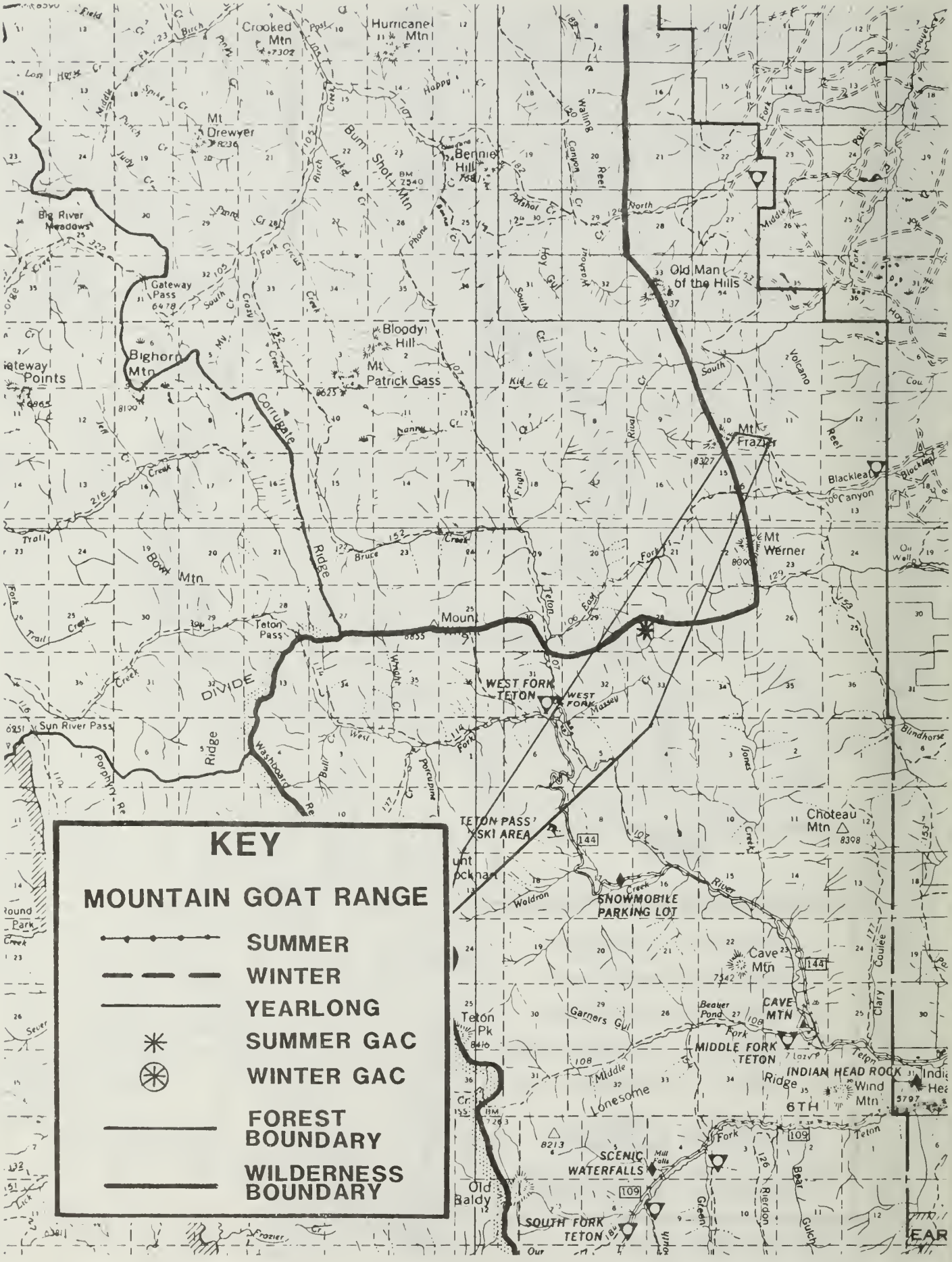


Figure 17. Yearlong home range and GAC of female mountain goat 5261.

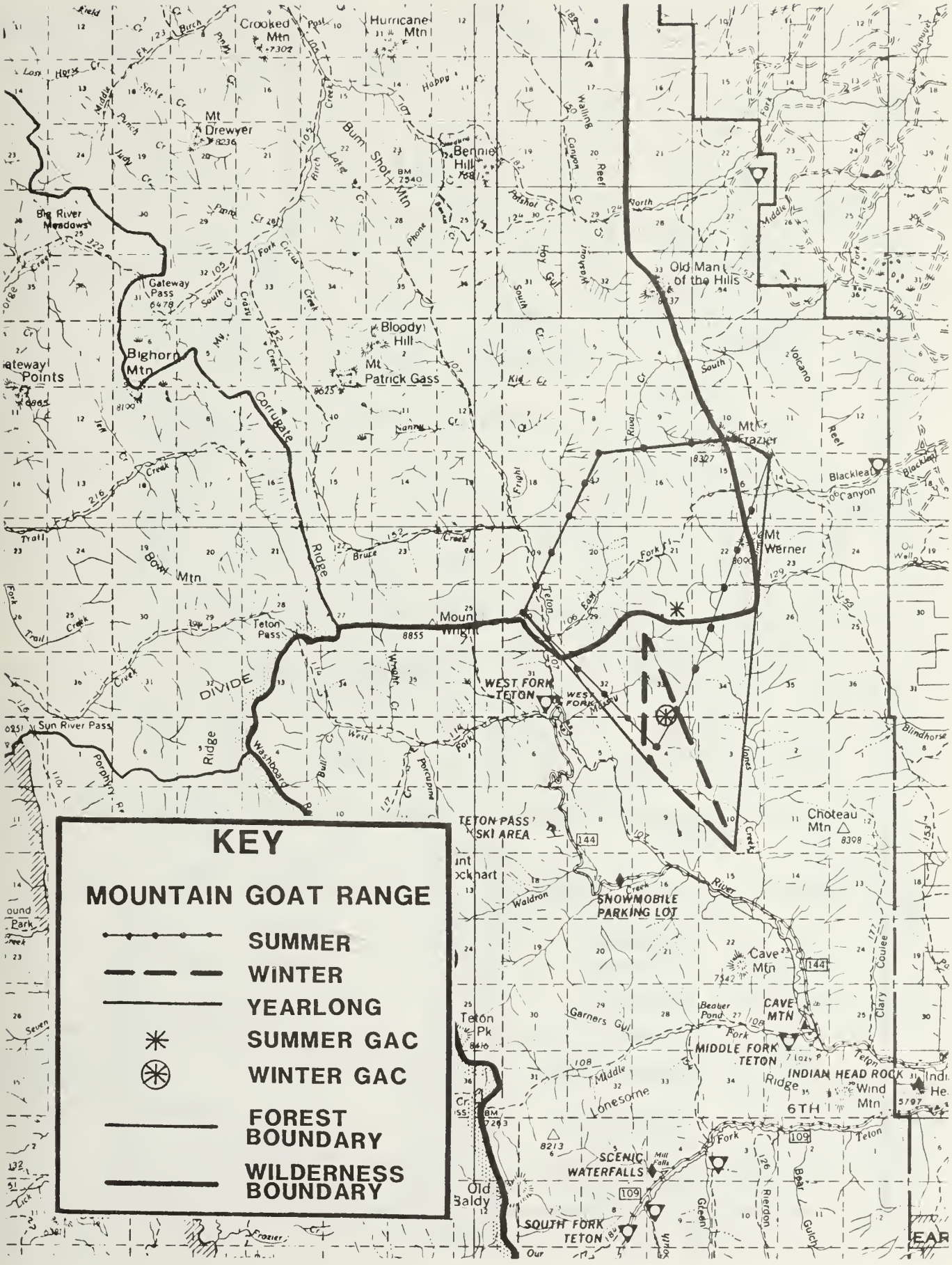


Figure 18. Summer, winter, and yearlong home range and GACs of female mountain goat 4301.

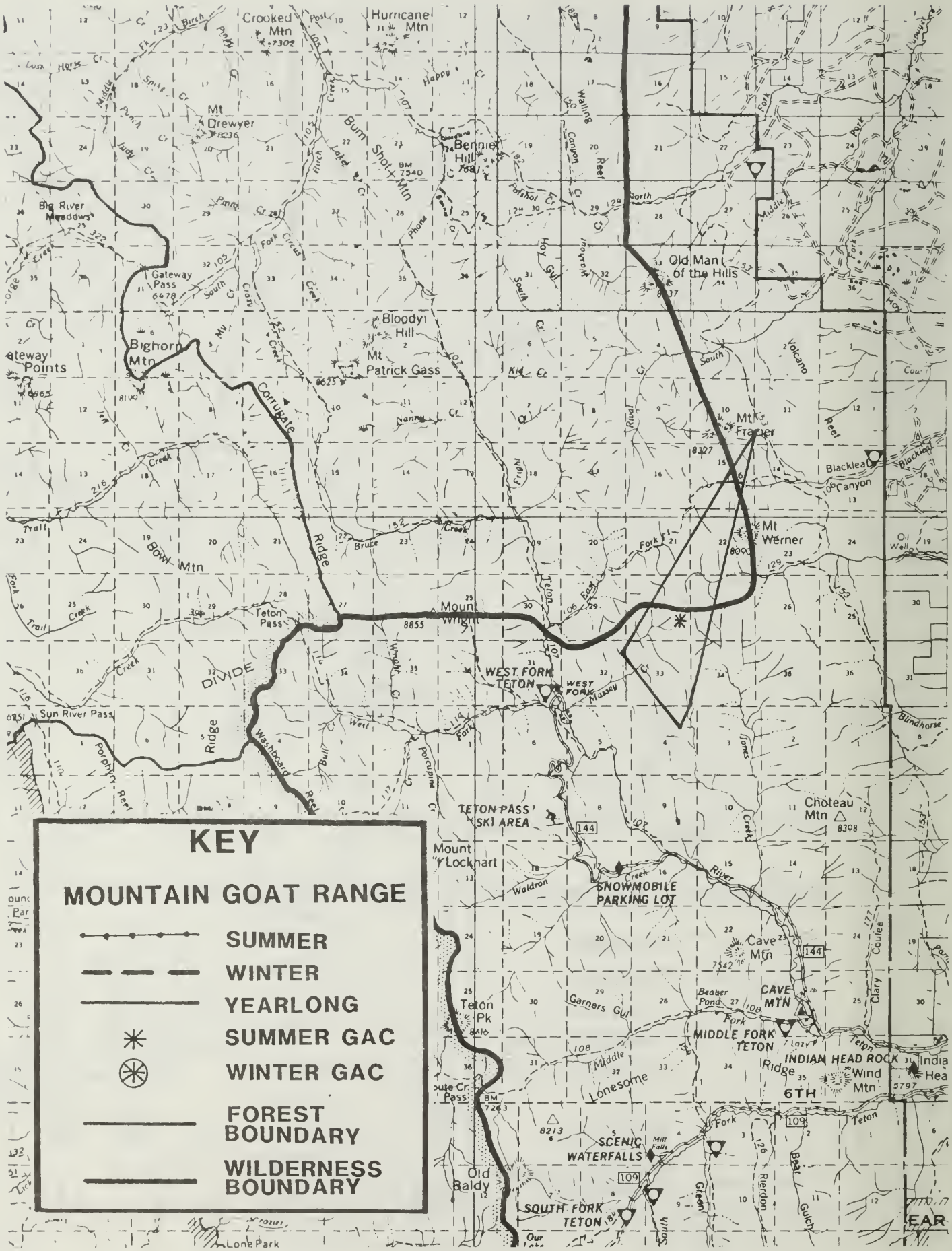


Figure 19. Yearlong home range and GAC of female mountain goat 9121.

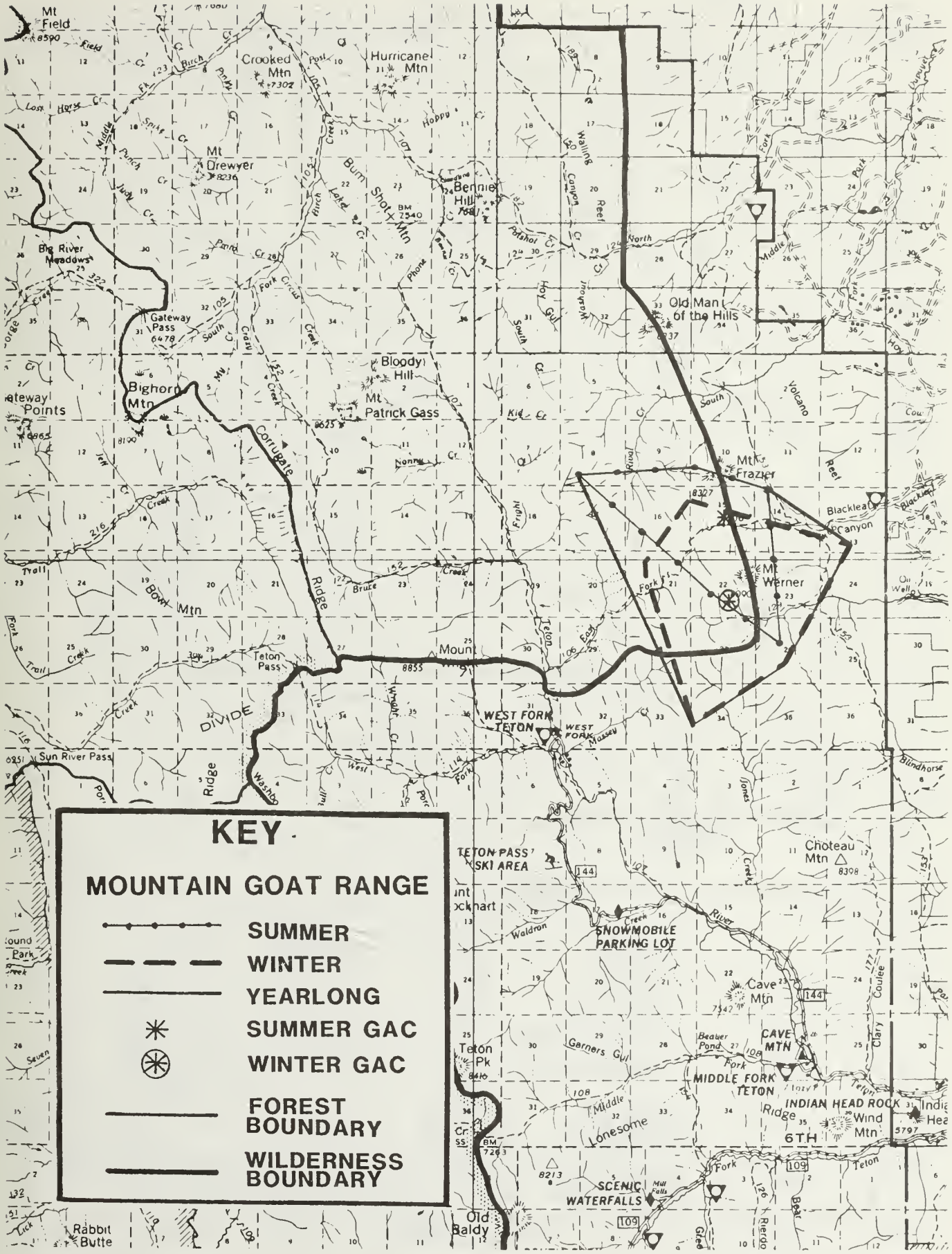


Figure 20. Summer, winter, and yearlong home range and GACs of female mountain goat 2302.

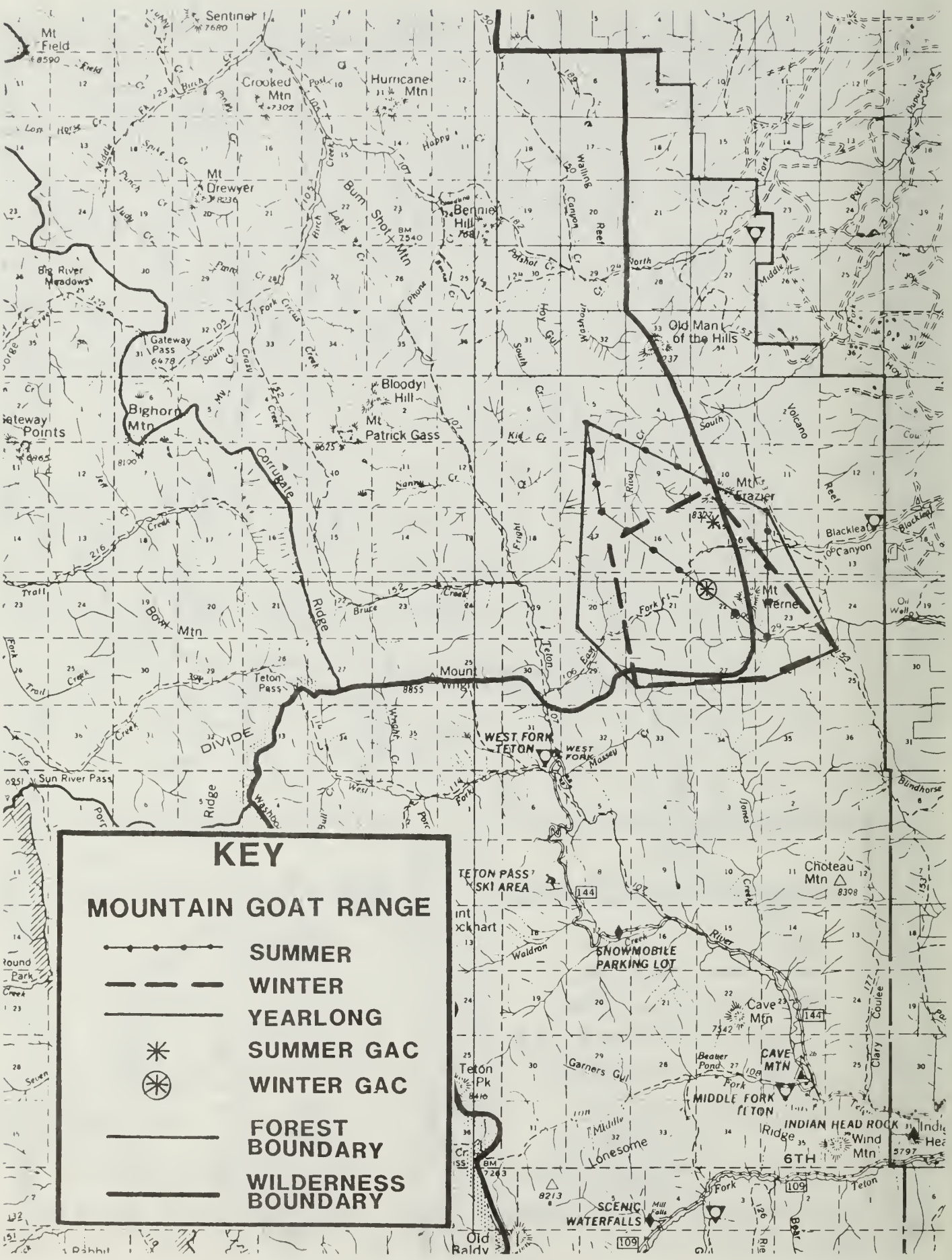


Figure 21. Summer, winter, and yearlong home range and GACs of female mountain goat 2402.

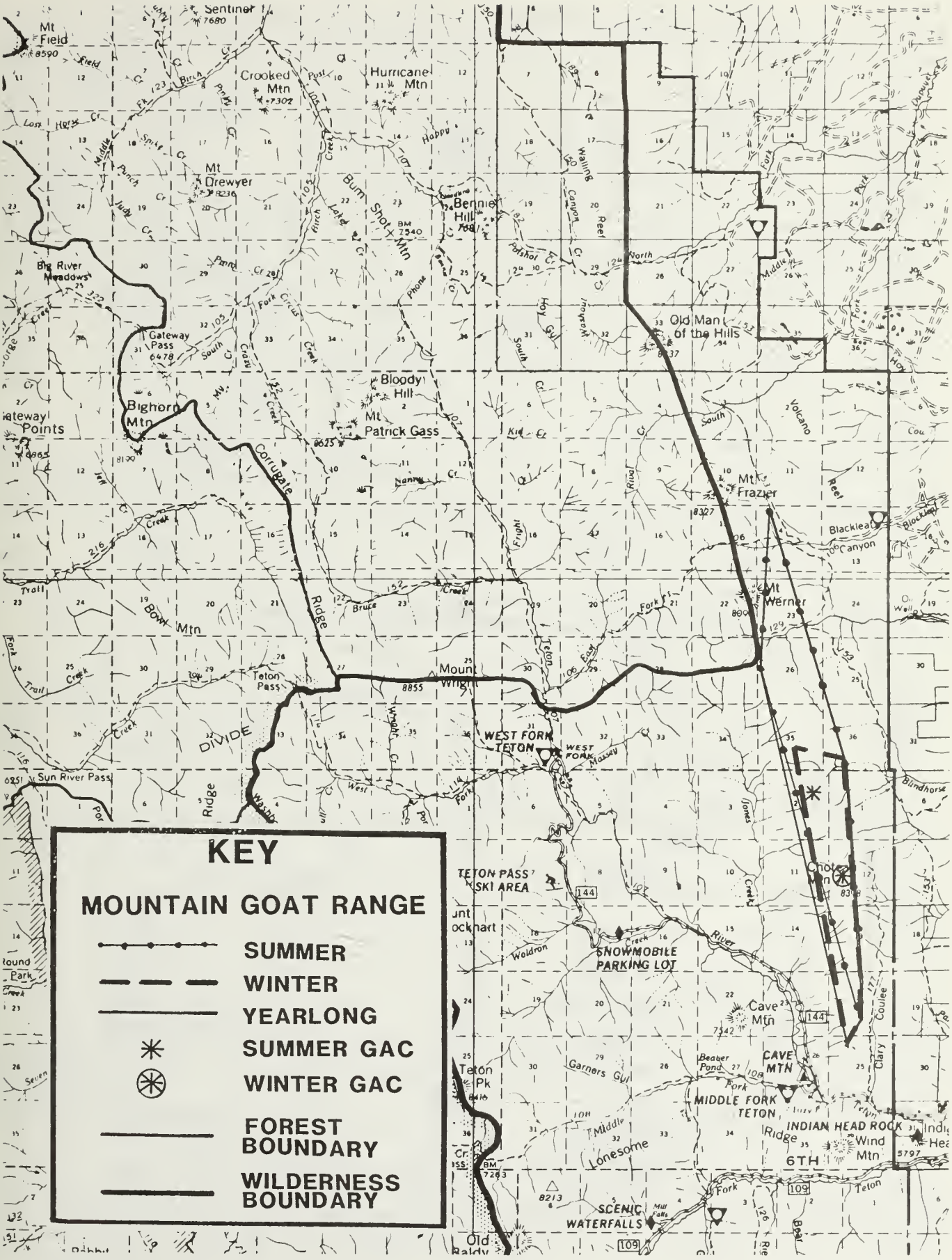


Figure 22. Summer, winter, and yearlong home range and GACs of female mountain goat 2902.

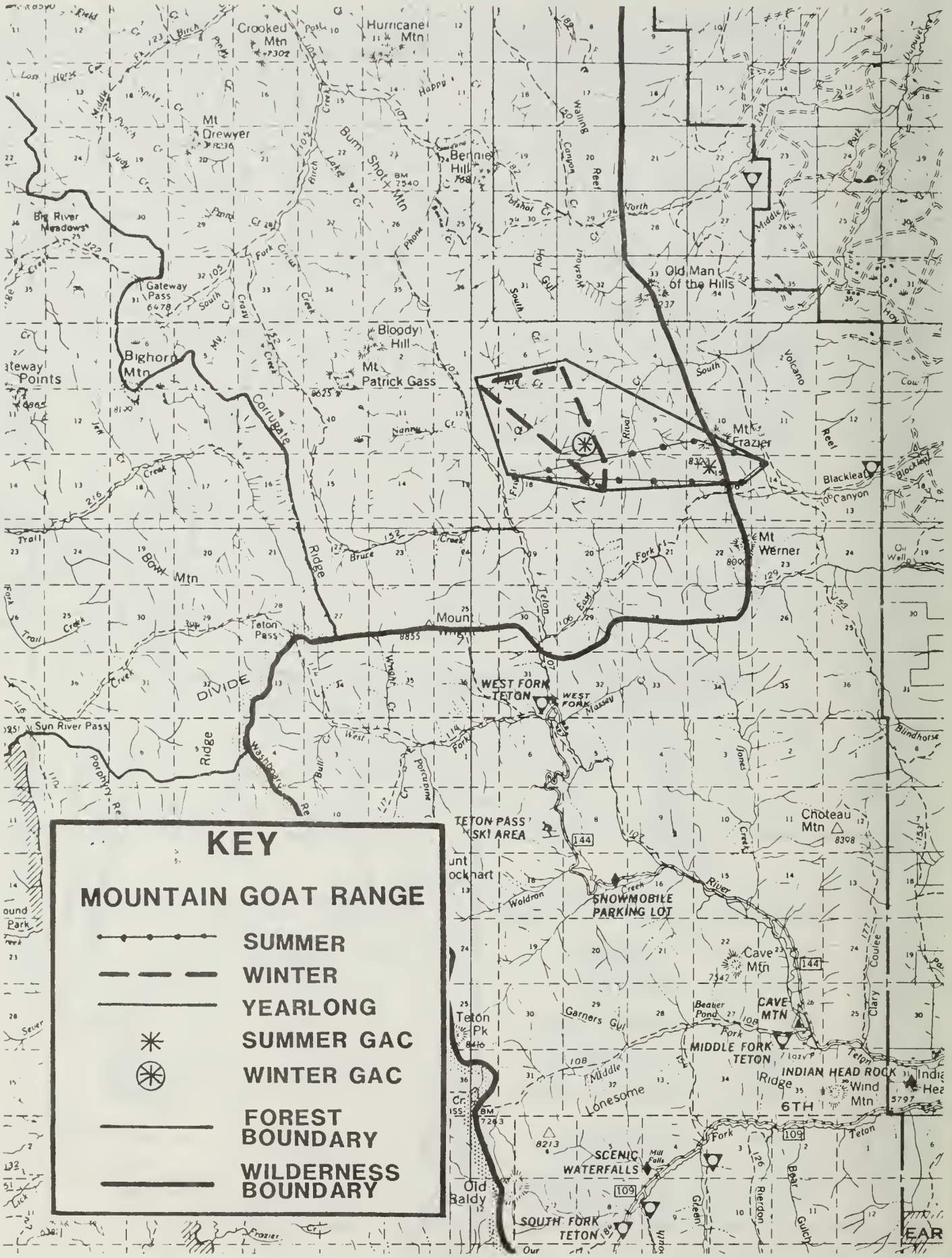


Figure 23. Summer, winter, and yearlong home range and GACs of female mountain goat 5302.

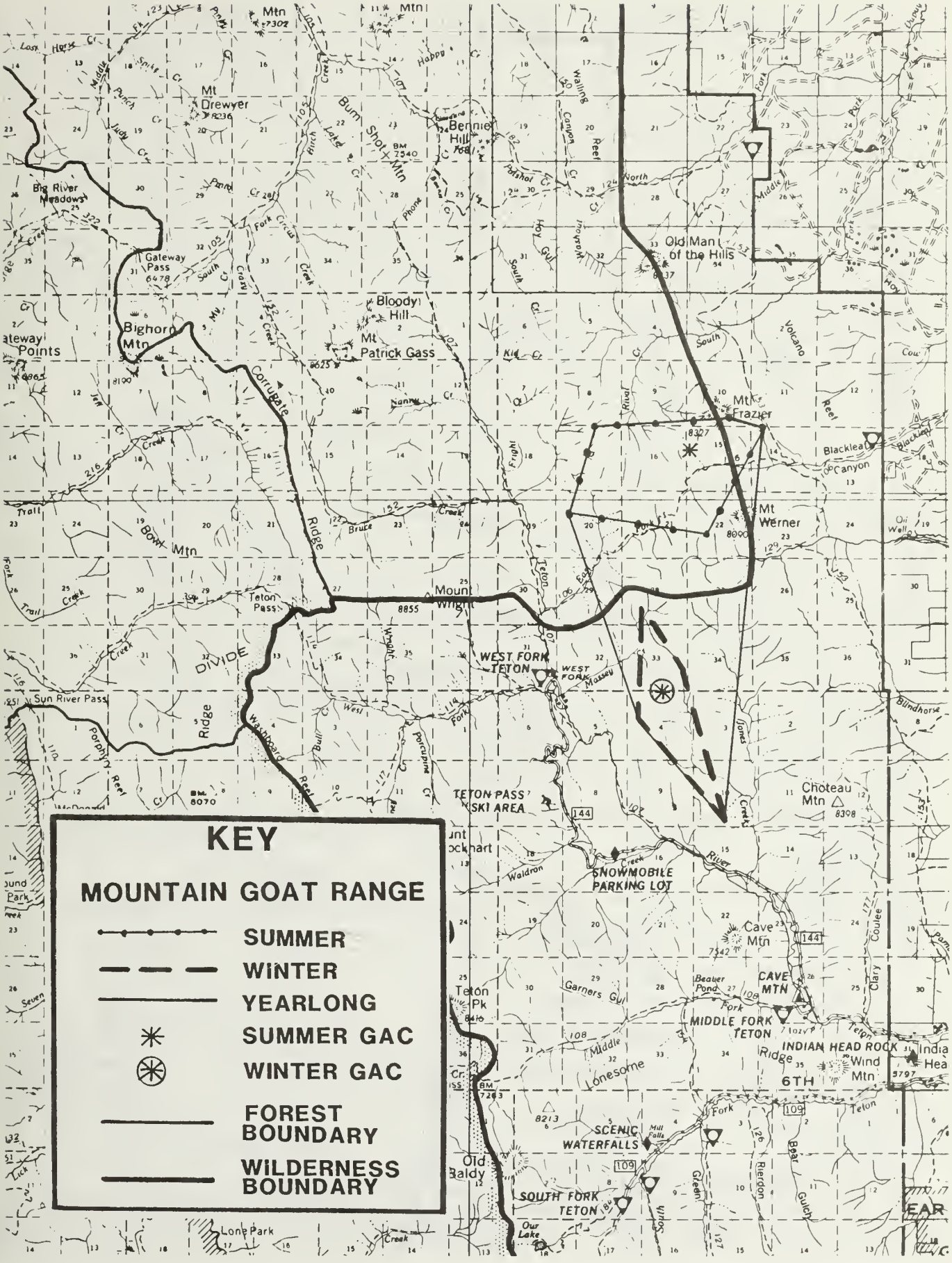


Figure 24. Summer, winter, and yearlong home range and GACs of male kid mountain goat 5902.

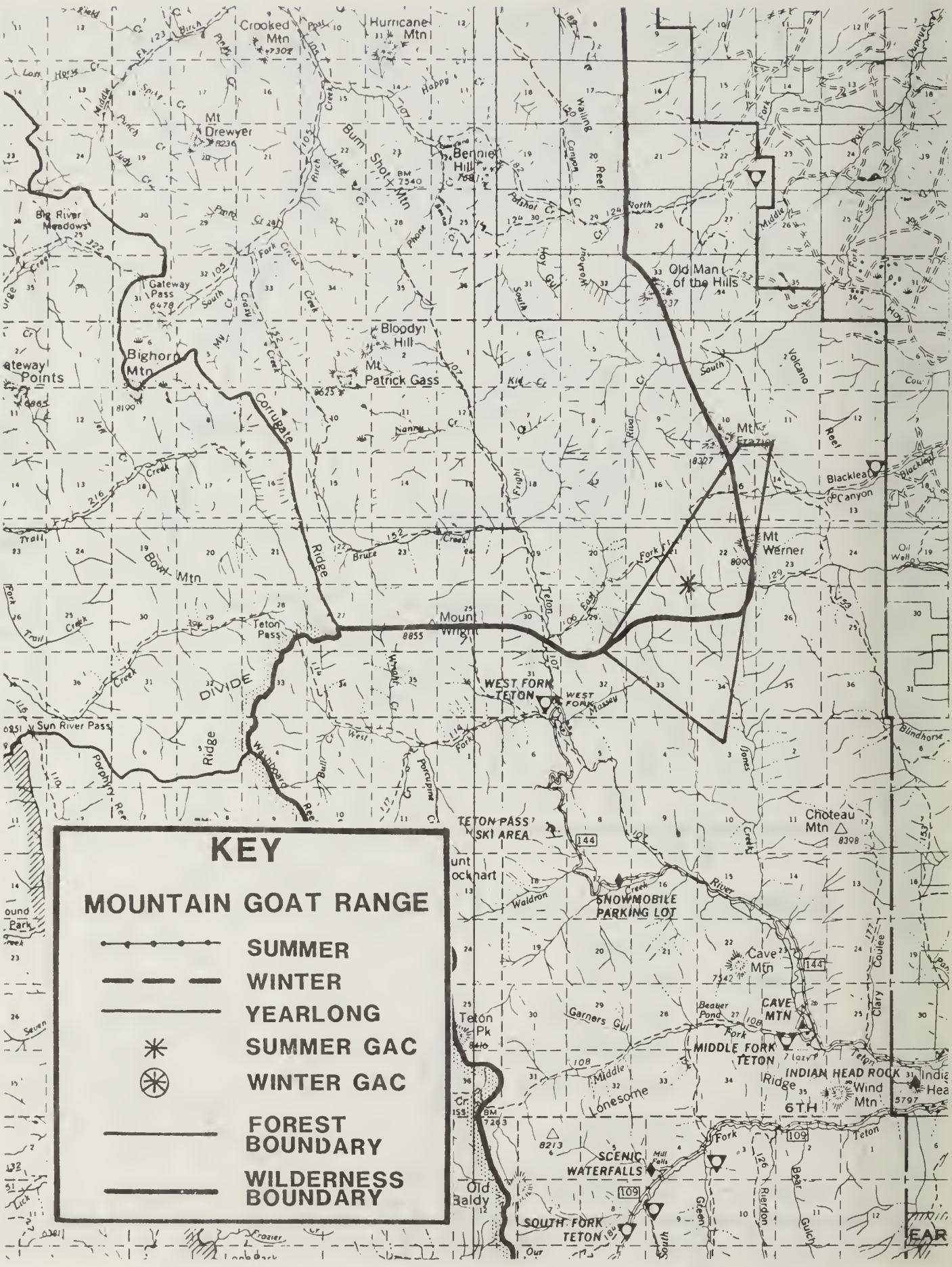


Figure 25. Yearlong home range and GAC of female mountain goat 4922.

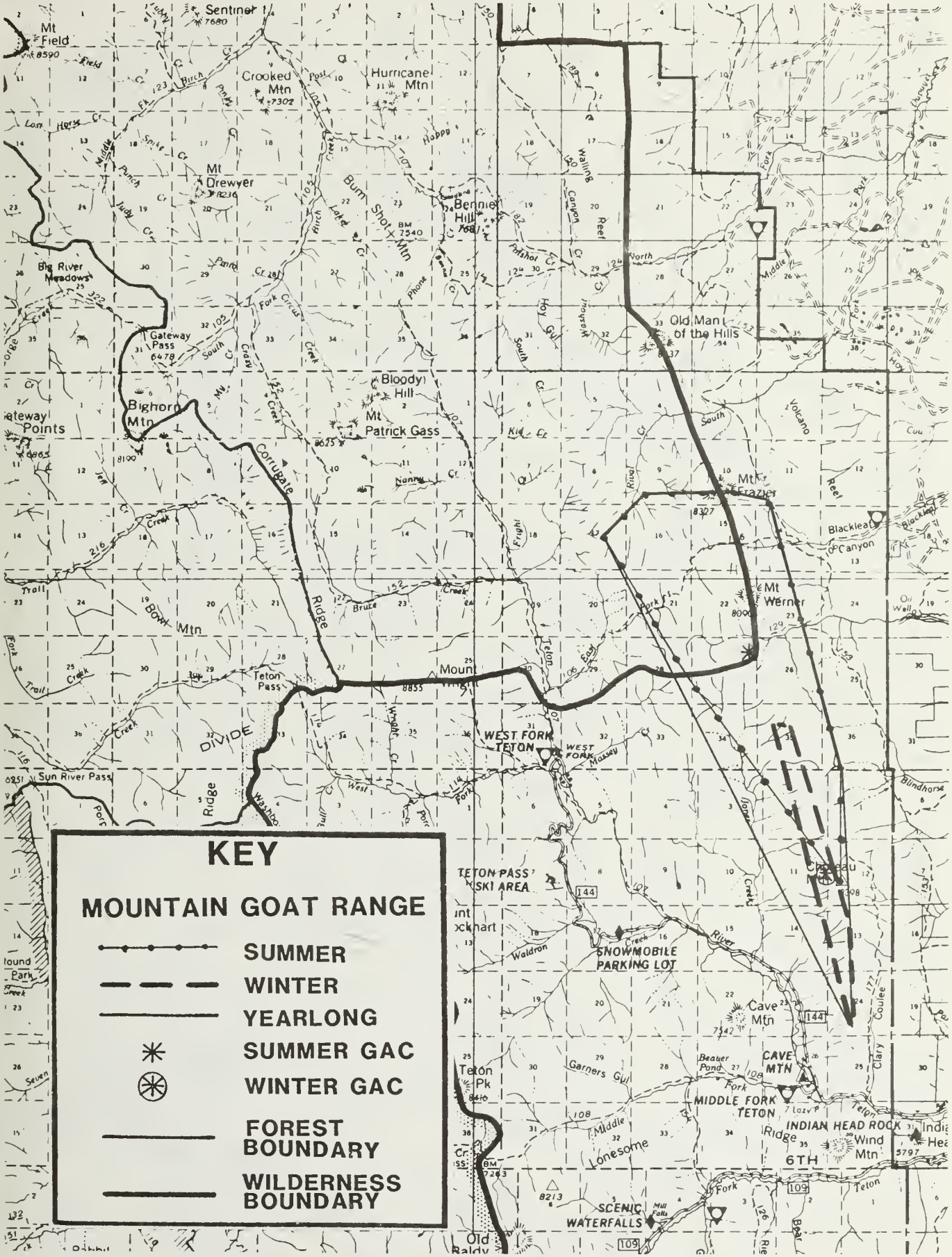


Figure 26. Summer, winter, and yearlong home range and GACs of female mountain goat 529.

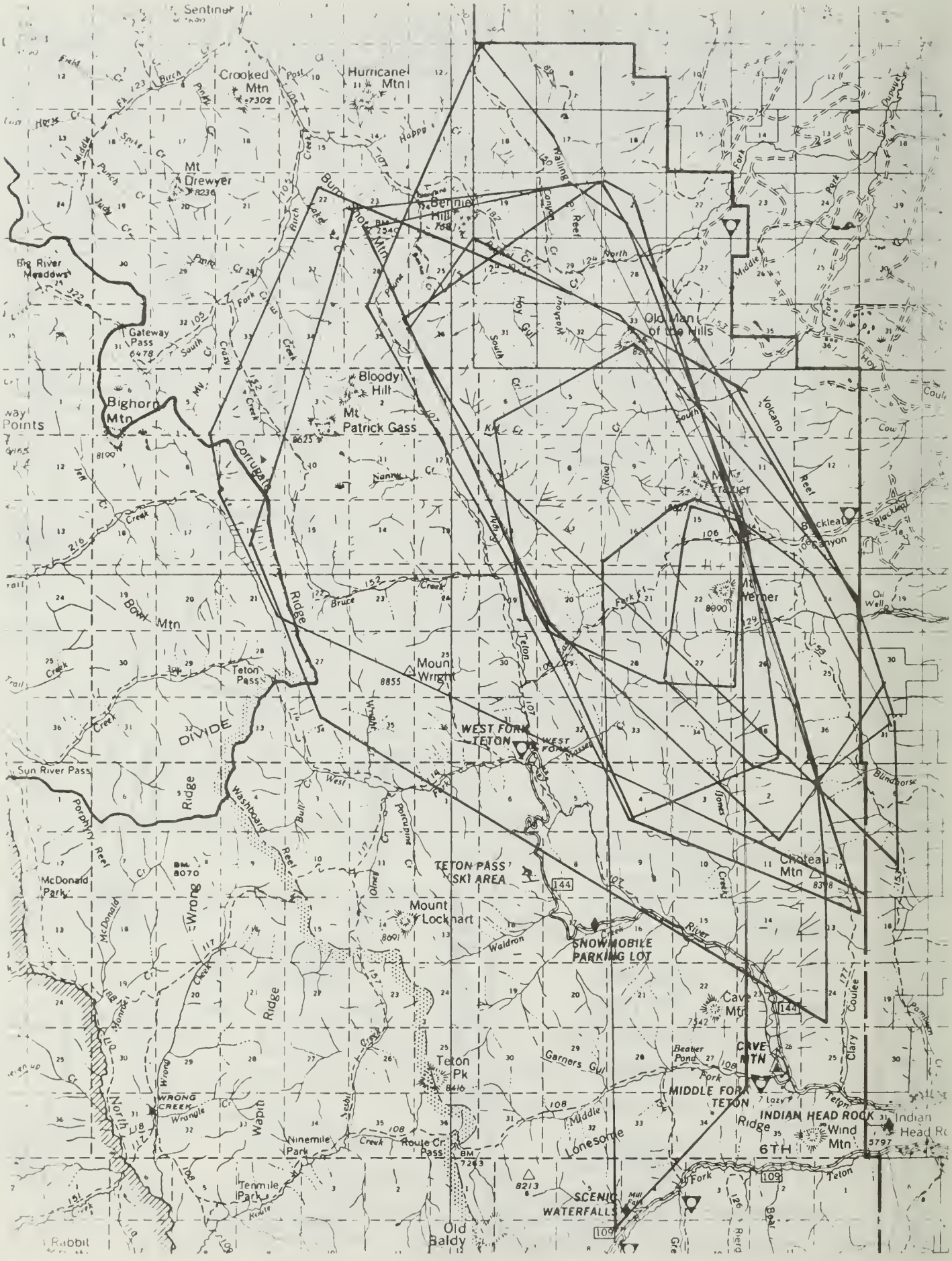


Figure 27. Yearlong home range of nine adult male mountain goats.

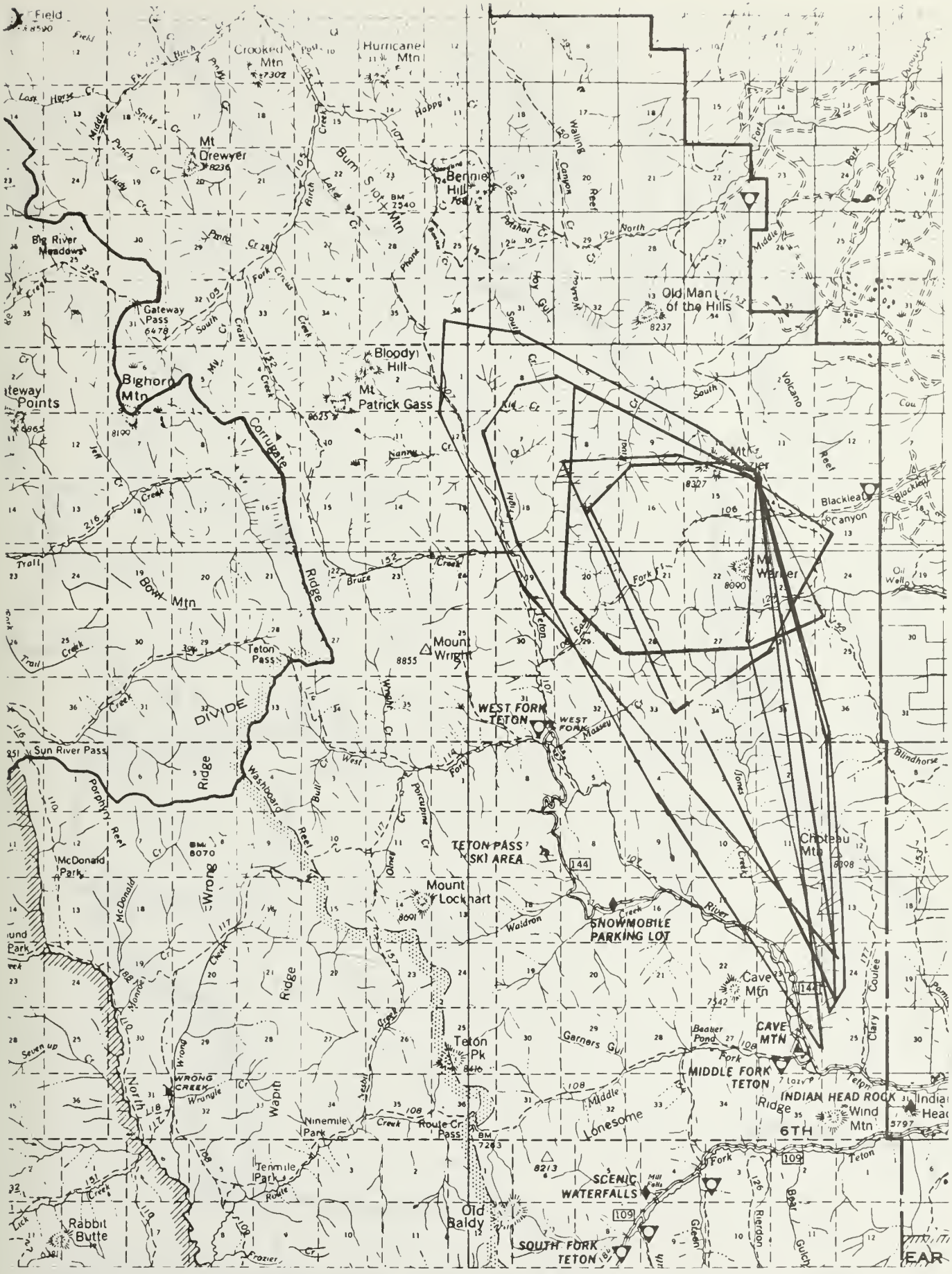


Figure 28. Yearlong home range of six adult female mountain goats.

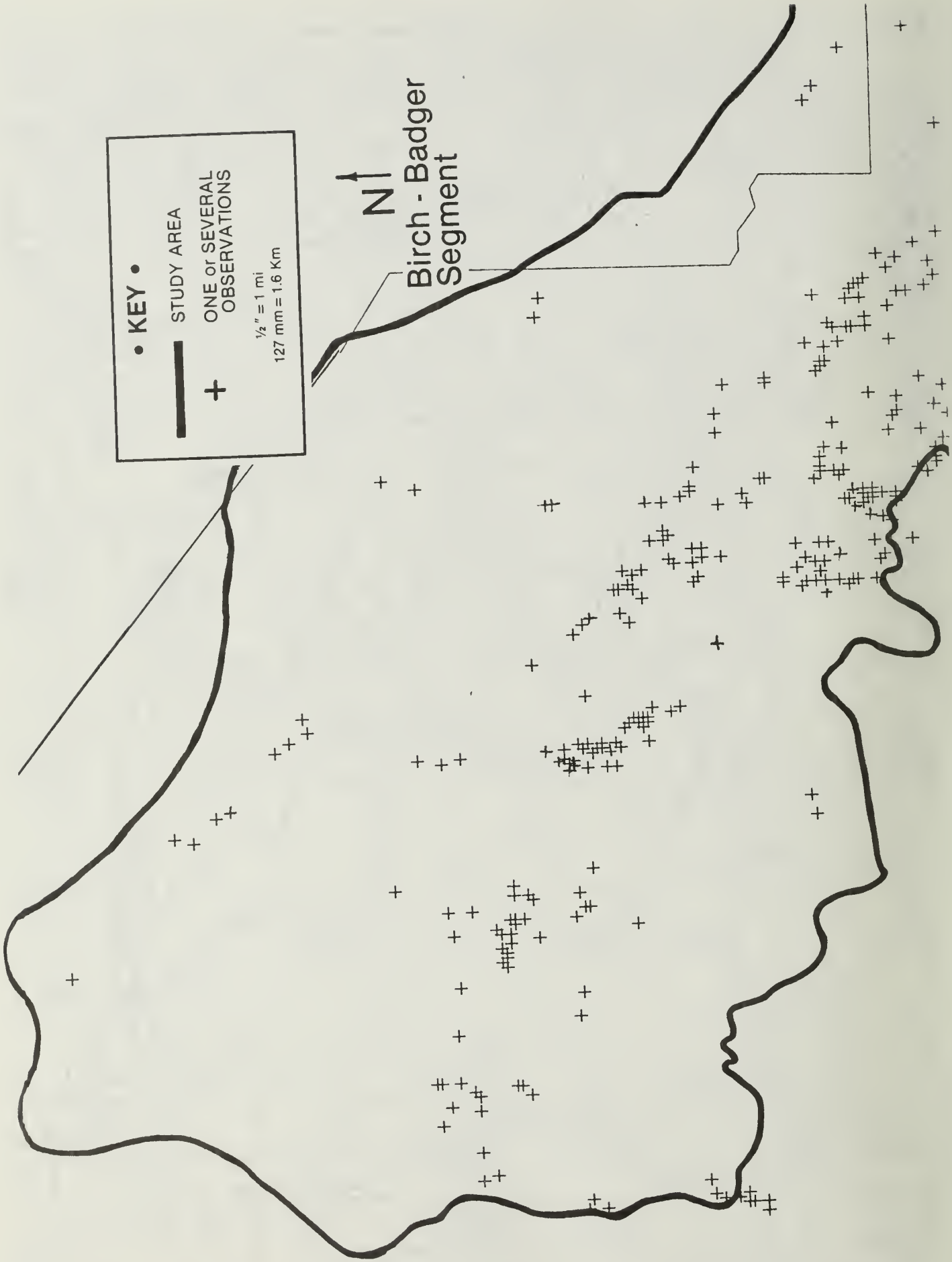
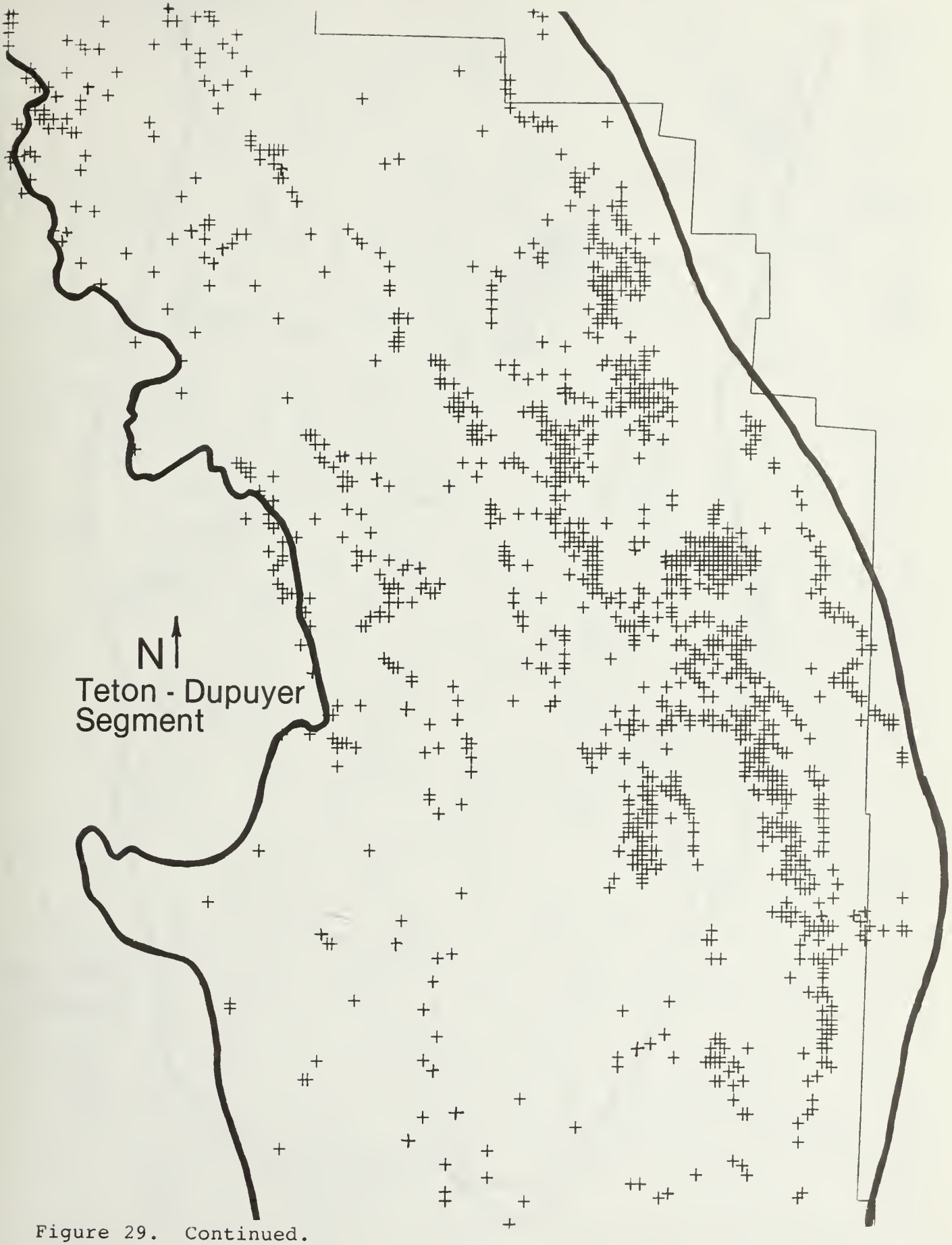


Figure 29. Mountain goat observation and kill records along the Rocky Mountain Front.



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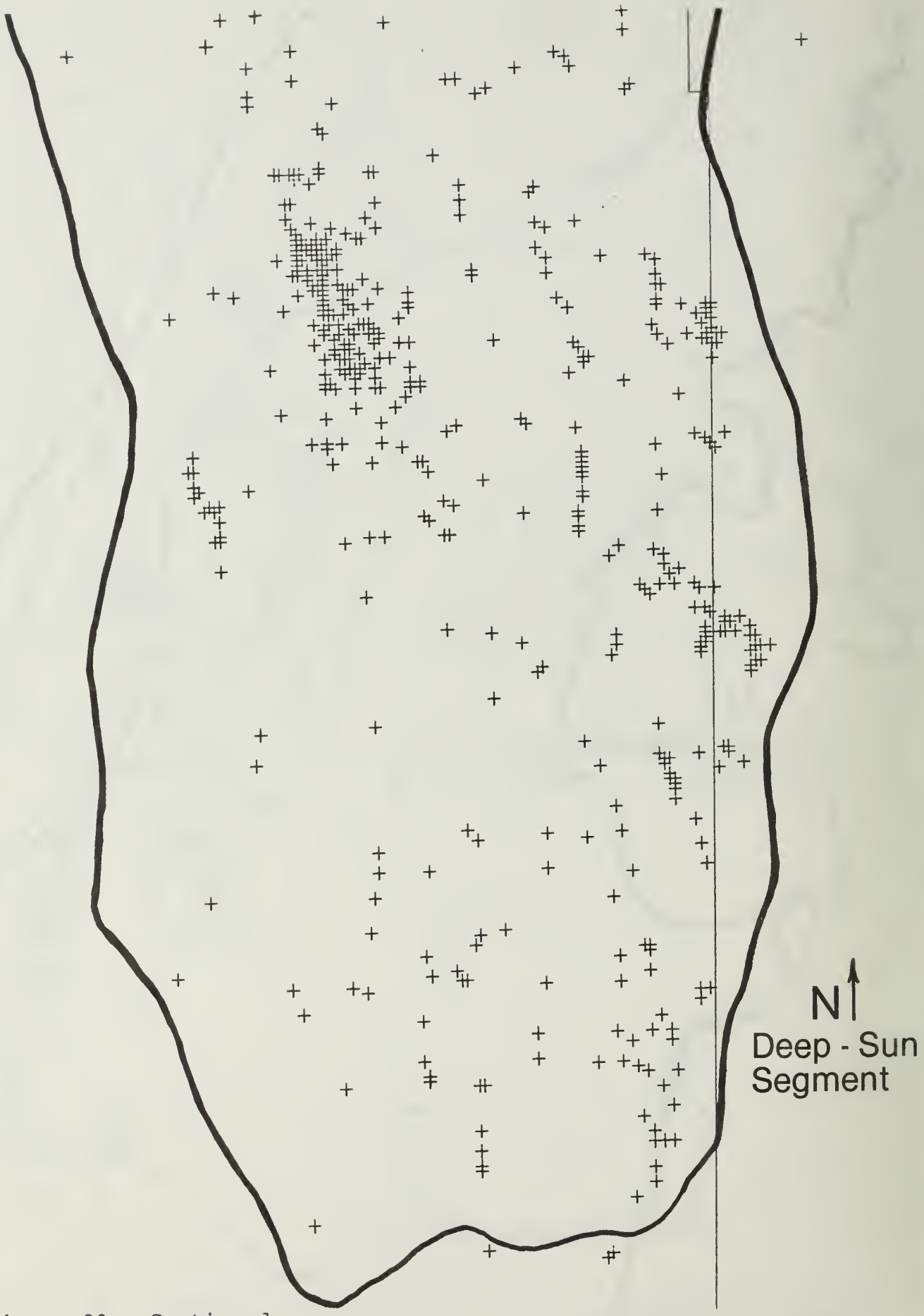
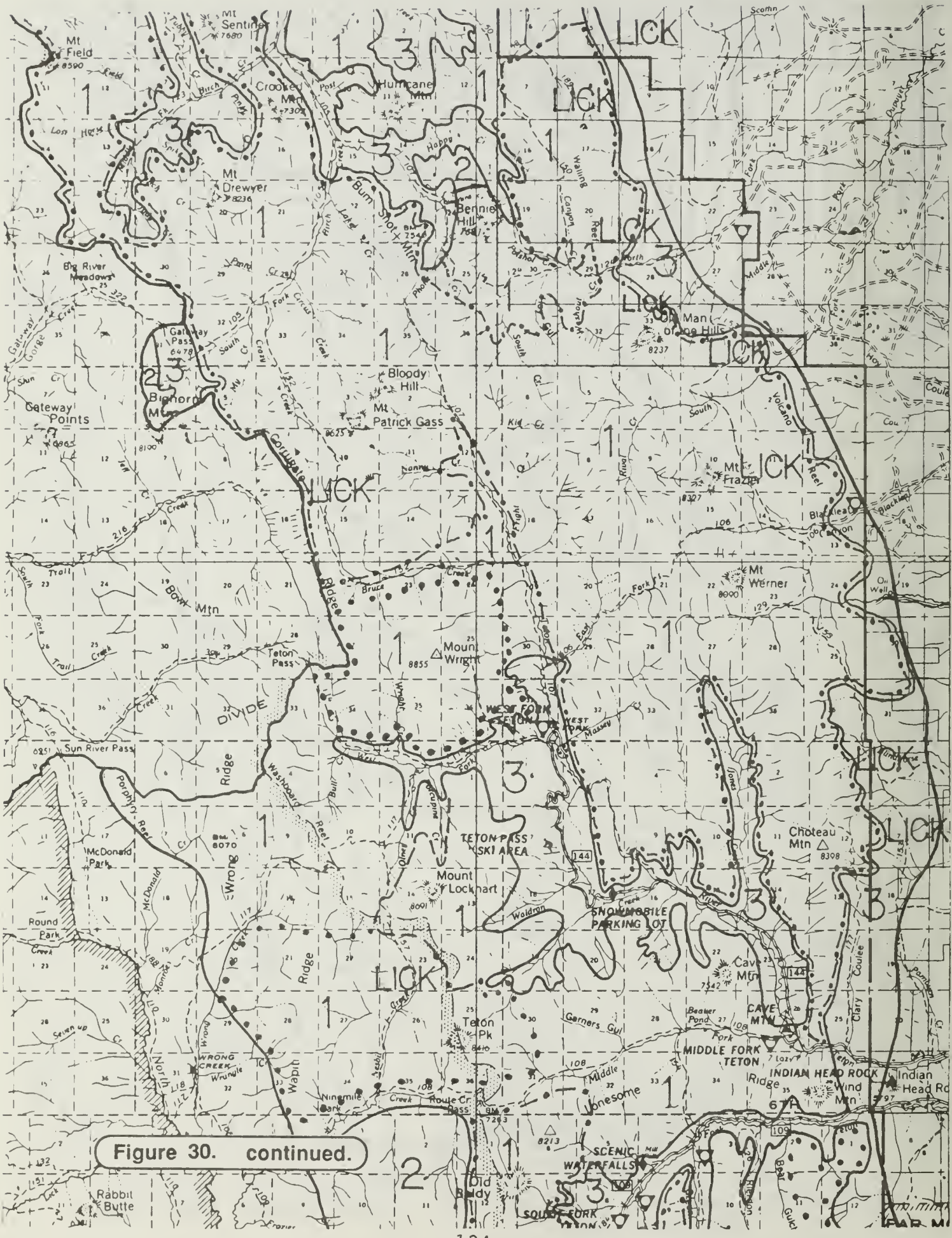


Figure 29. Continued.

Figure 30. Mountain goat seasonal habitat along the Rocky Mountain Front.



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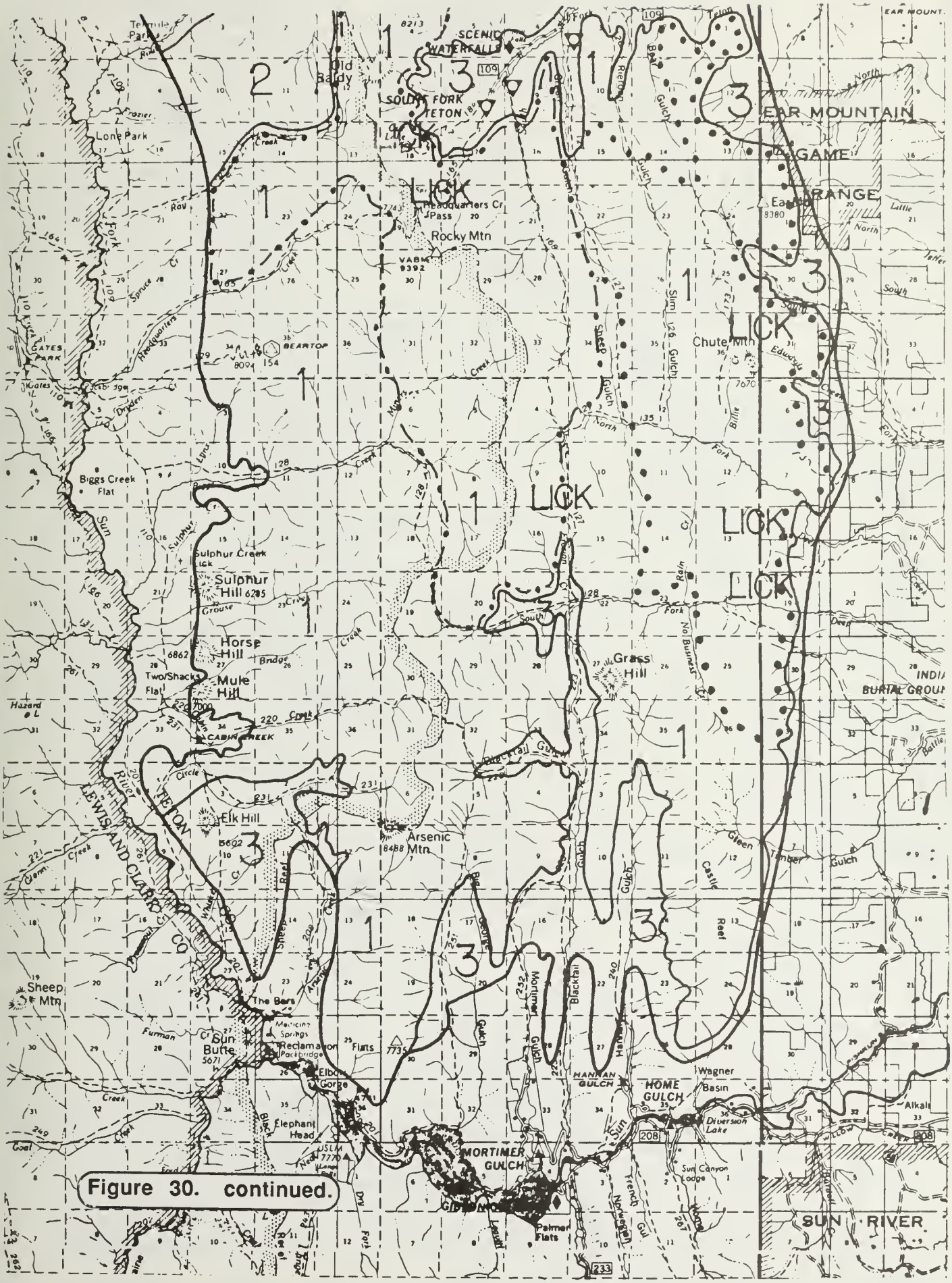

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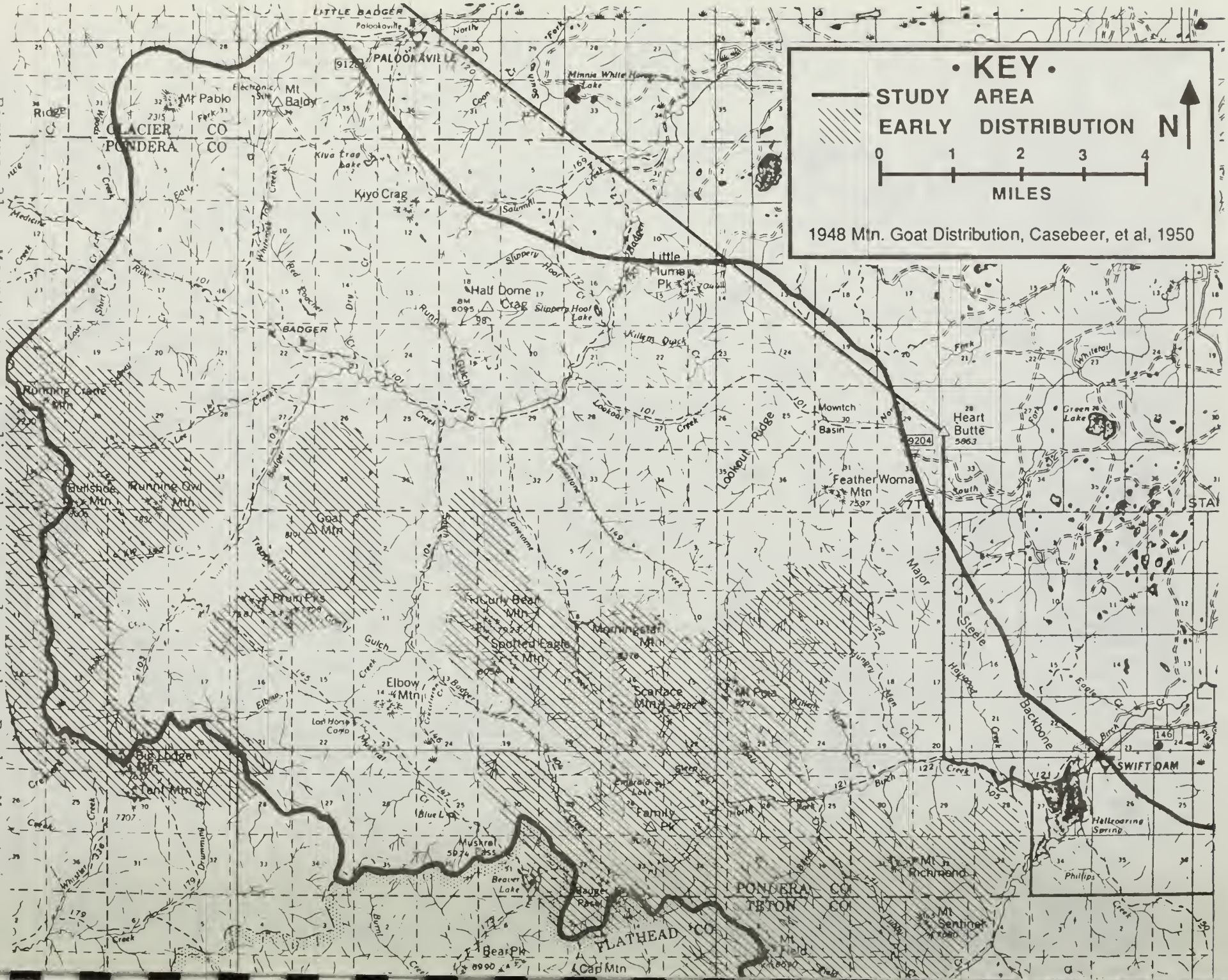


Figure 31. Mountain goat distribution along the Rocky Mountain Front, 1948.

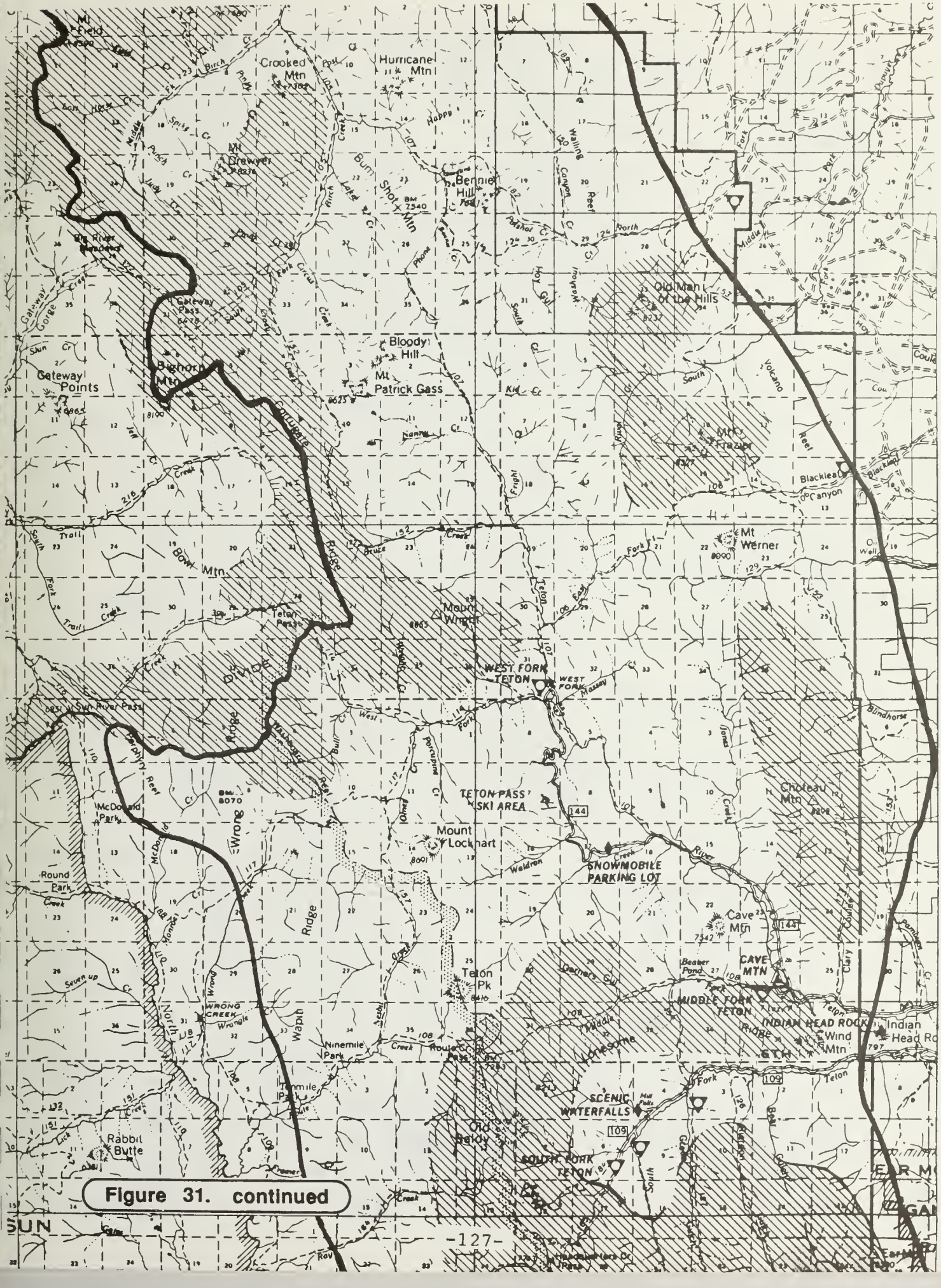
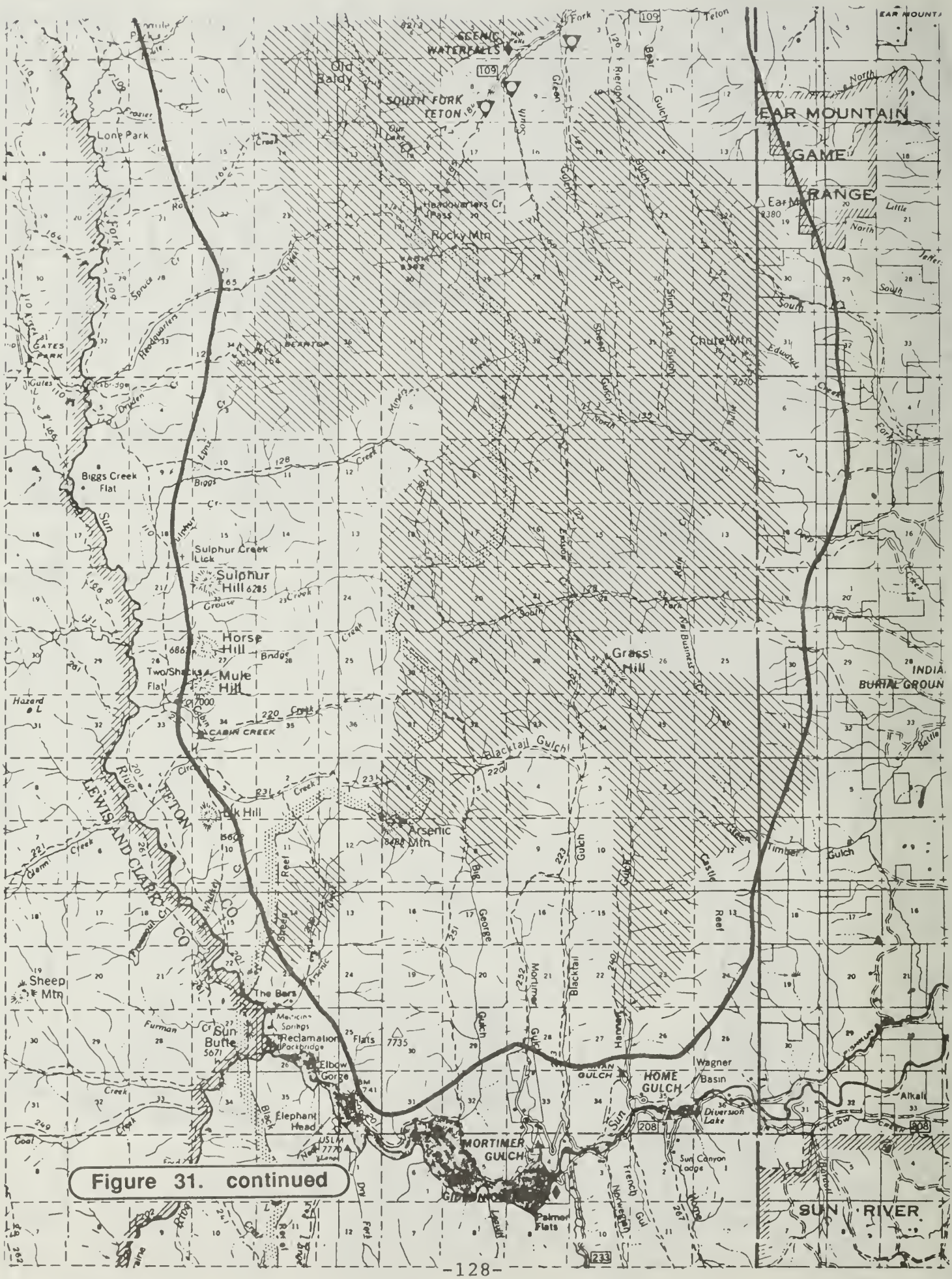


Figure 31. continued


SCENIC WATERFALLS
SOUTH FORK TETON R.
Old Baldy
Rocky Mtn
Headquarters Cr Pass
EAR MOUNTAIN GAME RANGE
Chute Mtn
Long Park
GATES PARK
BEARTOP
Biggs Creek Flat
Sulphur Creek Lick
Sulphur Hill 6285
Horse Hill
Two Shacks
Mule Hill
CABIN CREEK
Grass Hill
INDIA BURIAL GROUN
Blacktail Gulch
Arsenic Mtn
Oak Hill
LEWIS AND CLARK CO
TETON
Sheep Mtn
The Barn
Sun Butte 5671
Medicine Springs Reclamation Packbridge
Elbow Gorge
Elephant Head
MORTIMER GULCH
HOME GULCH
Wagner Basin
Diversion Lake
Sun Canyon Lodge
Palmer Flats
SUN RIVER
Alkali
Timber Gulch
Reef
Sun
Teton
Dry
Little
South
North
Fork
Creek
Gulch
Mtn
Pass
Lake
Ridge
Bear
Spruce
Edwards
Sheep
Furman
Arsenic
Blacktail
George
Mountain
Hannan
Castle
Trench
Northwest
Brown
Dearborn
Battle
Deep
Cool
Black
Elbow
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Flats
Gulch
Creek
Fork

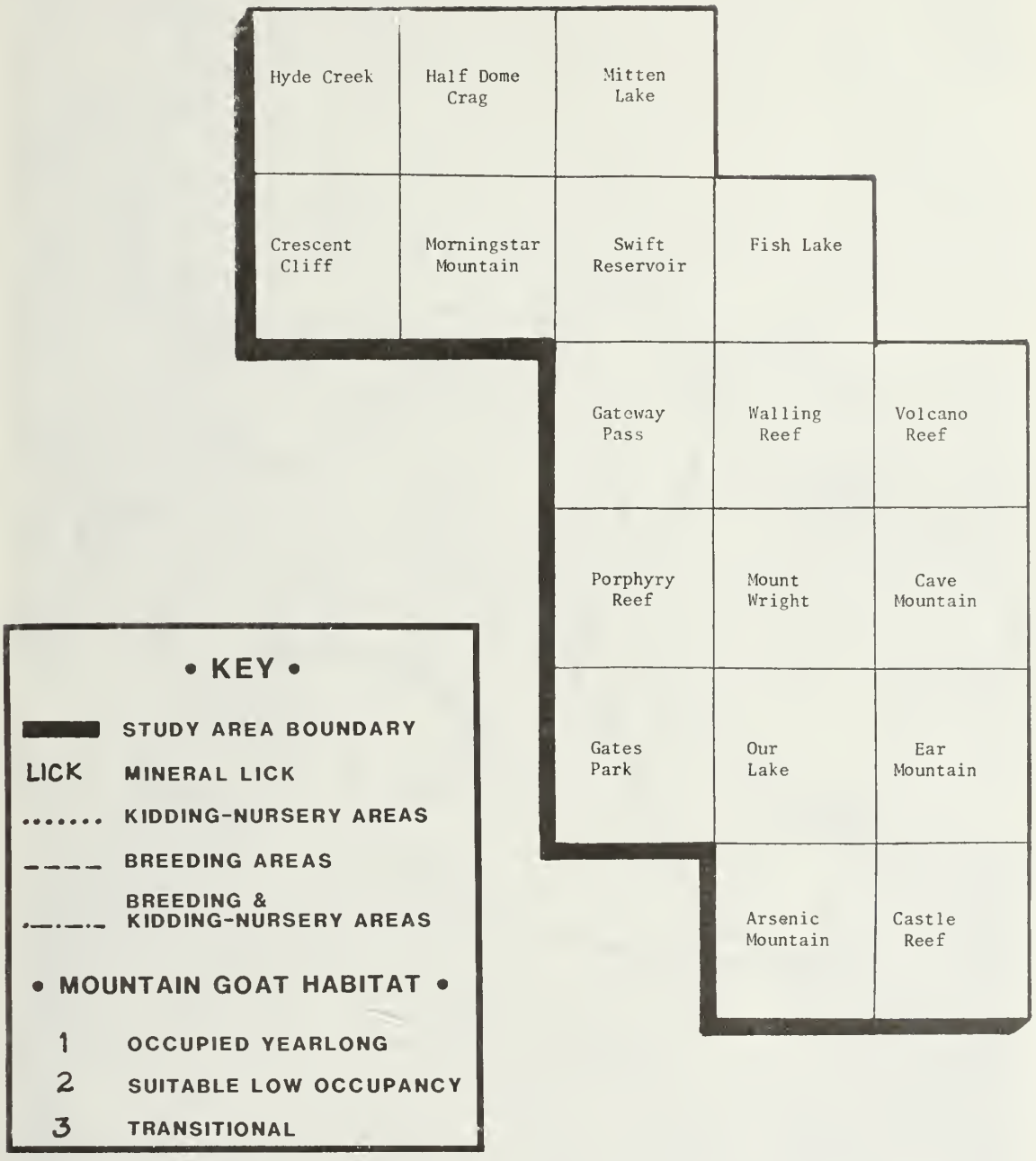


Figure 32. Guide and key to topographic maps of mountain goat seasonal use areas on the Rocky Mountain Front.

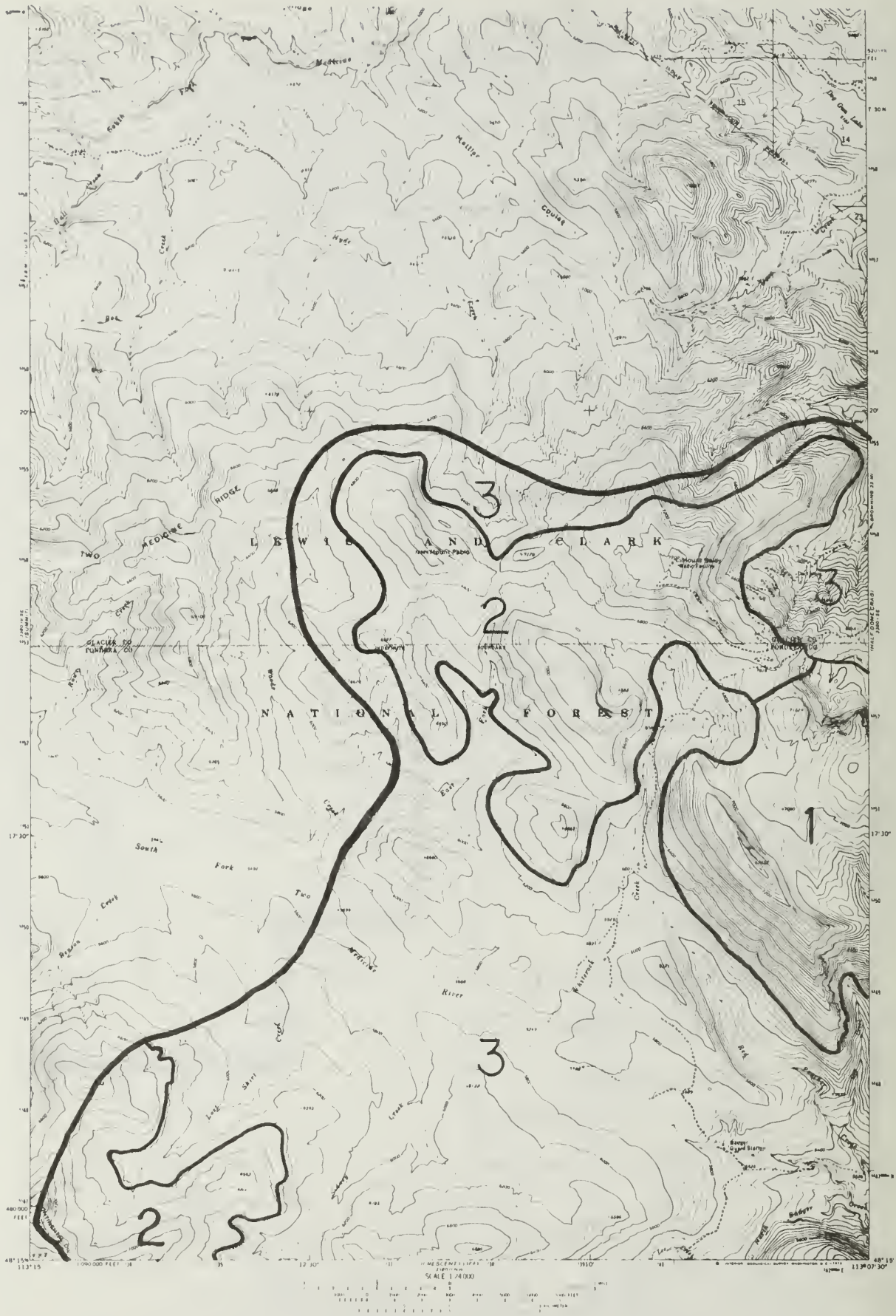


Figure 33. Mountain goat seasonal use areas - Hyde Creek.

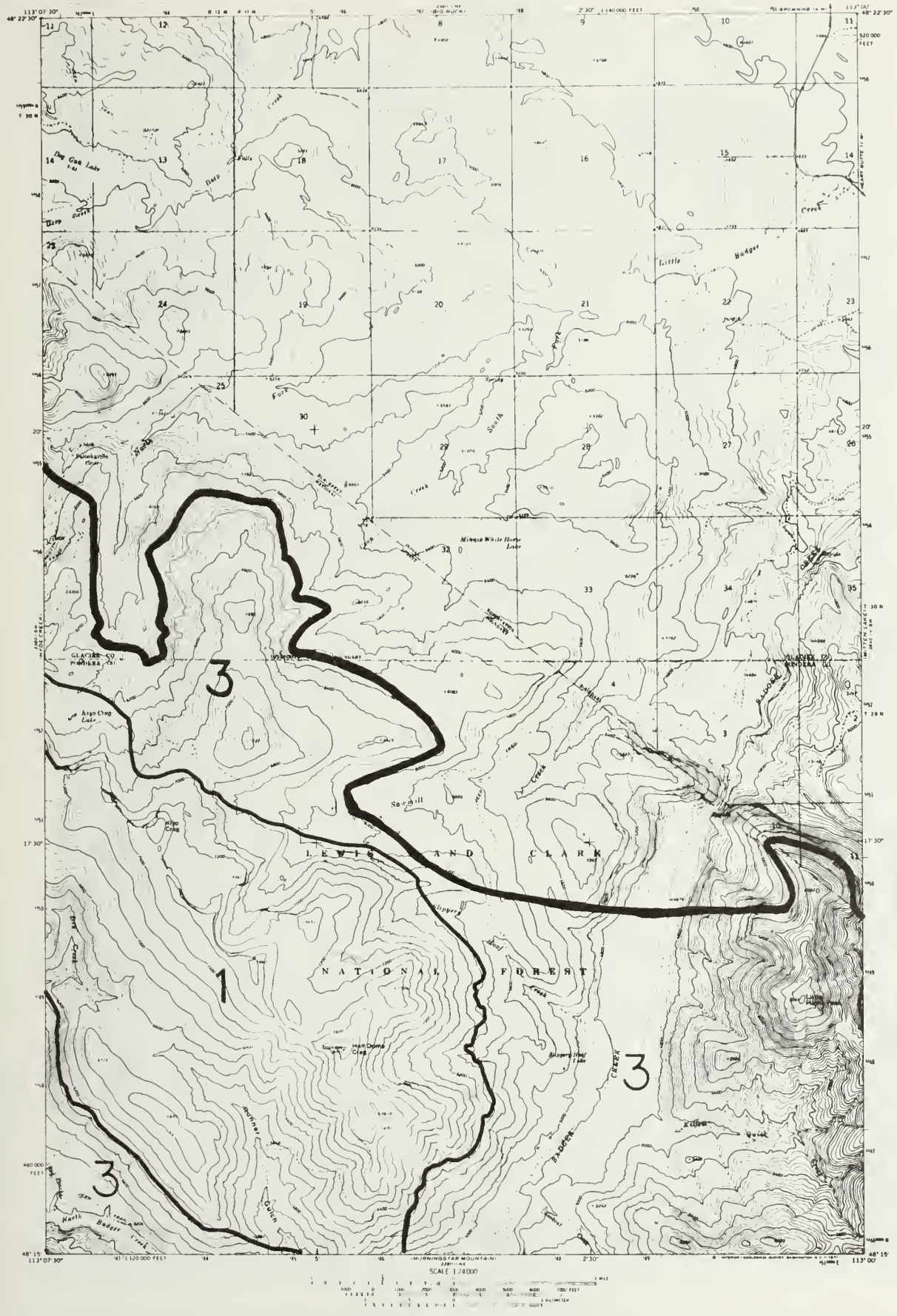


Figure 34. Mountain goat seasonal use areas - Half Dome Crag.

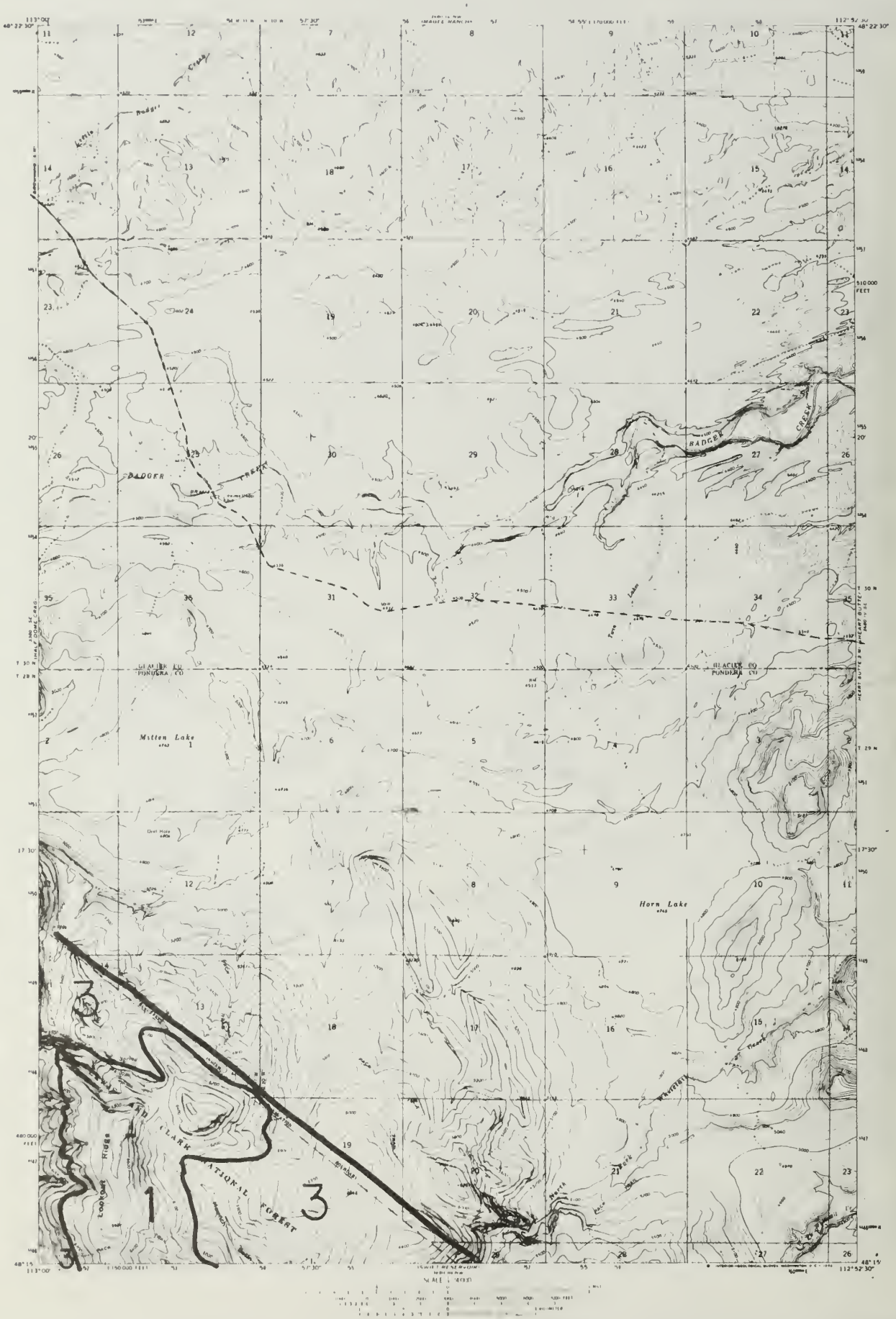


Figure 35. Mountain goat seasonal use areas - Mitten Lake.

Figure 36. Mountain goat seasonal use areas - Crescent Cliff.

Figure 37. Mountain goat seasonal use areas - Morningstar Mountain.

Figure 38. Mountain goat seasonal use areas - Swift Reservoir.

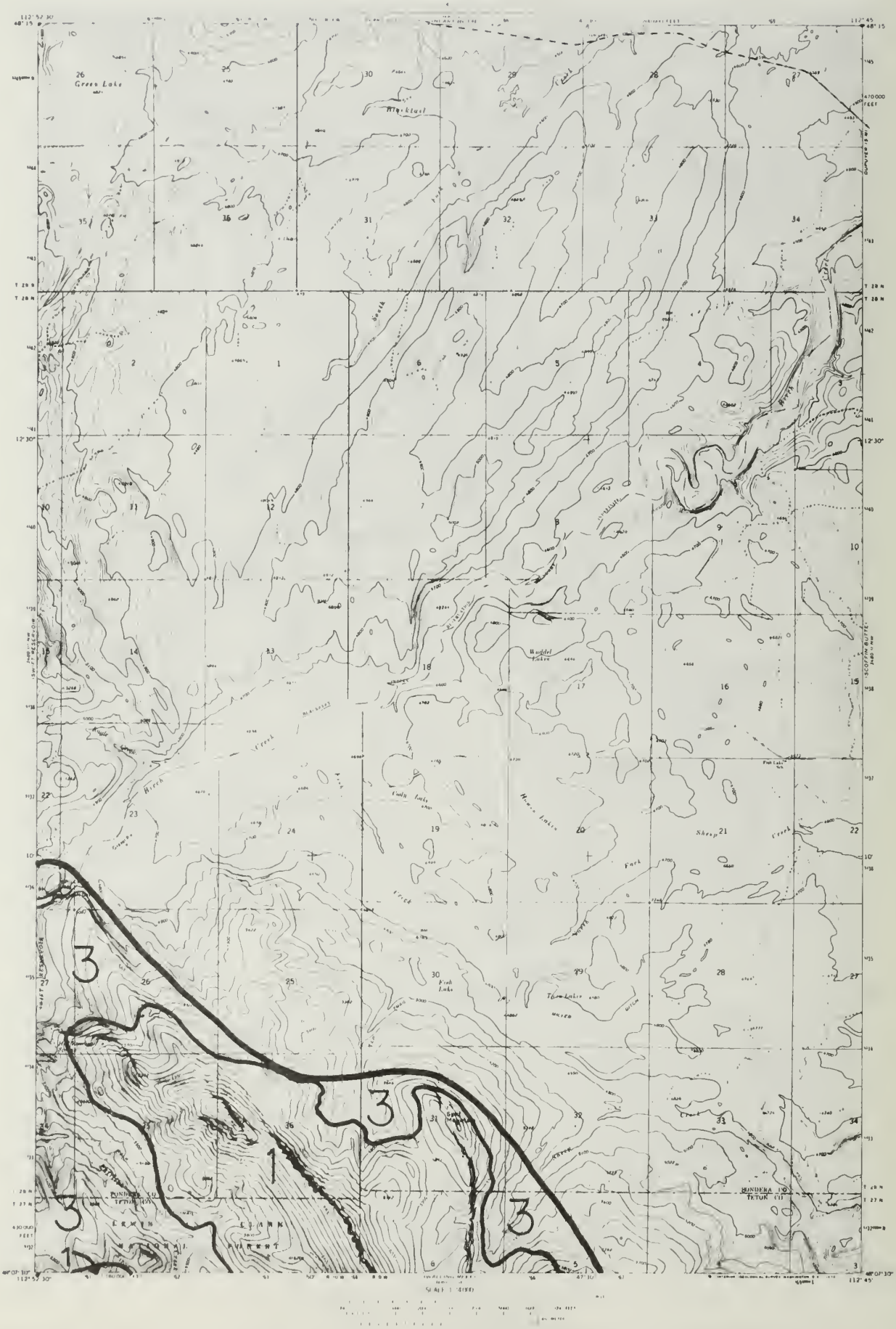


Figure 39. Mountain goat seasonal use areas - Fish Lake.

Figure 40. Mountain goat seasonal use areas - Gateway Pass.

Figure 41. Mountain goat seasonal use areas - Walling Reef.

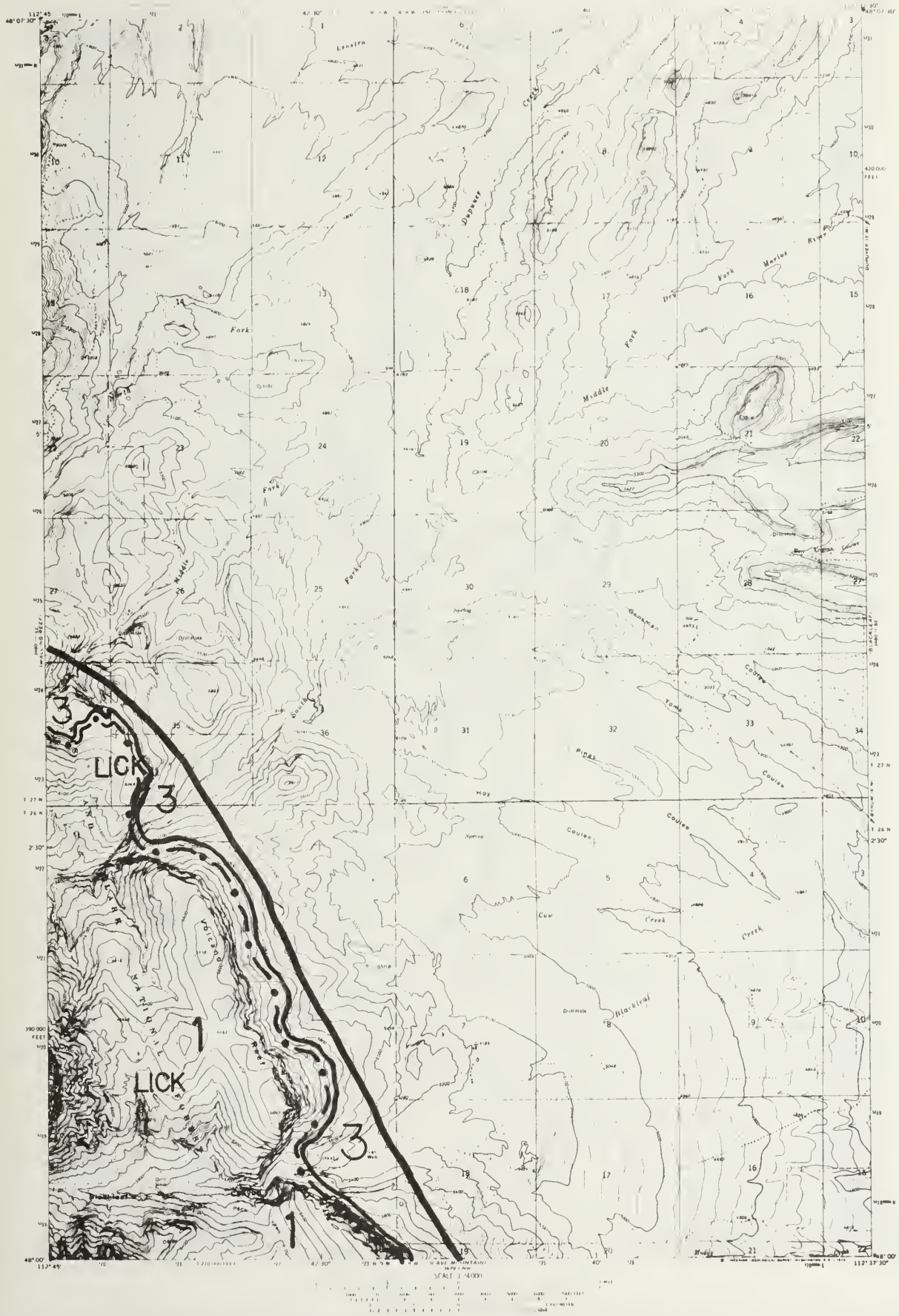


Figure 42. Mountain goat seasonal use areas - Volcano Reef.

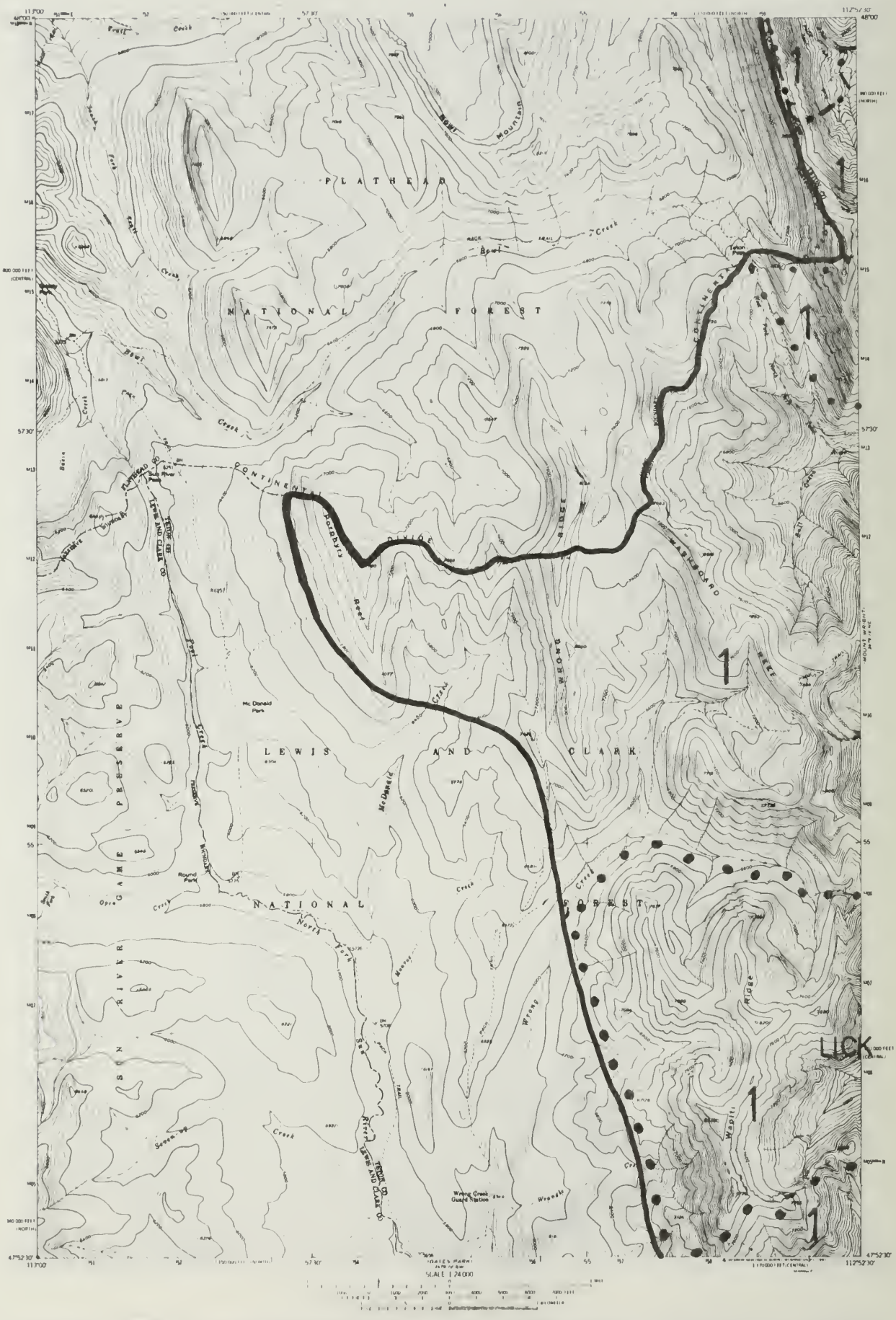


Figure 43. Mountain goat seasonal use areas - Porphyry Reef.

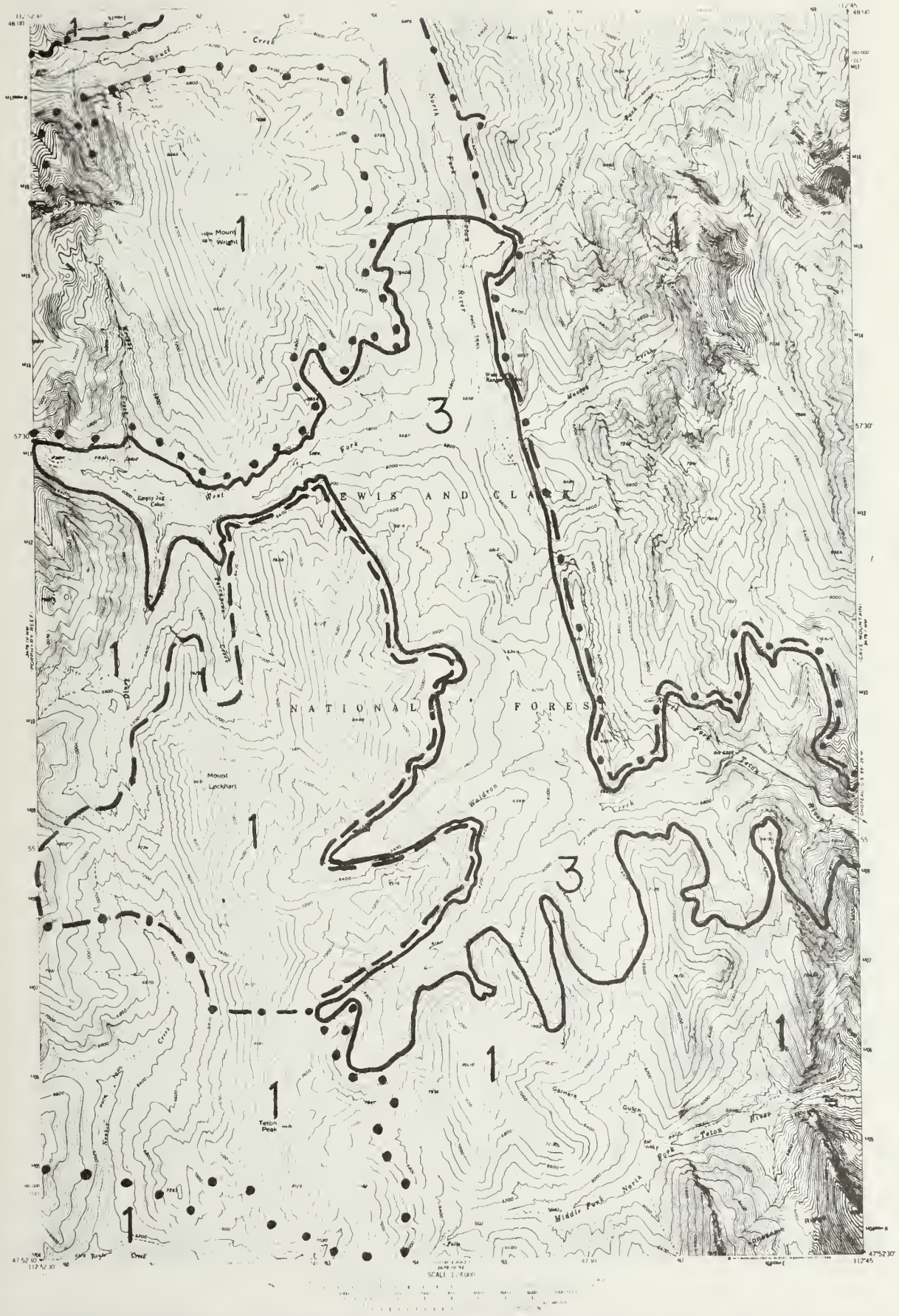


Figure 44. Mountain goat seasonal use areas - Mount Wright.

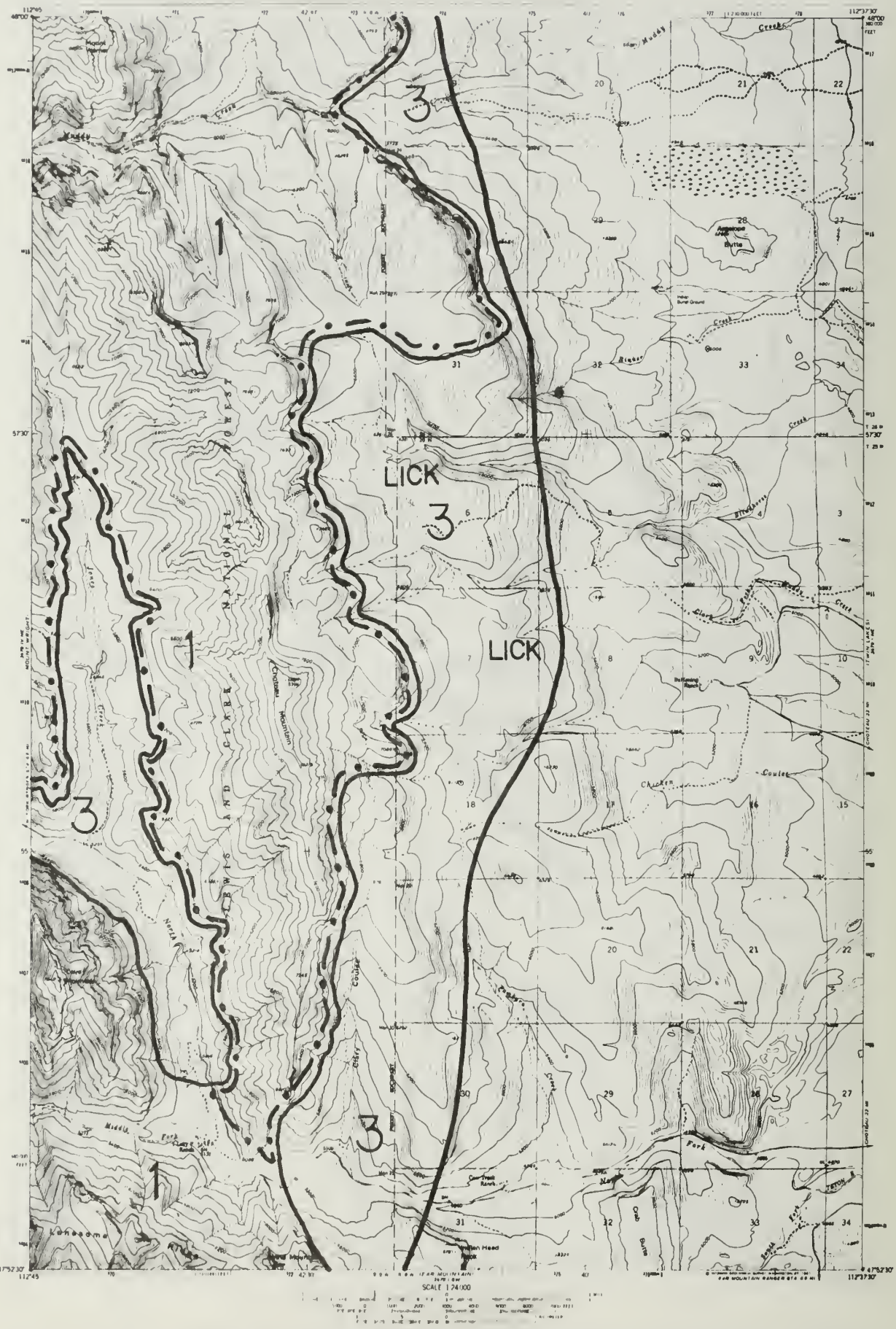


Figure 45. Mountain goat seasonal use areas - Cave Mountain.

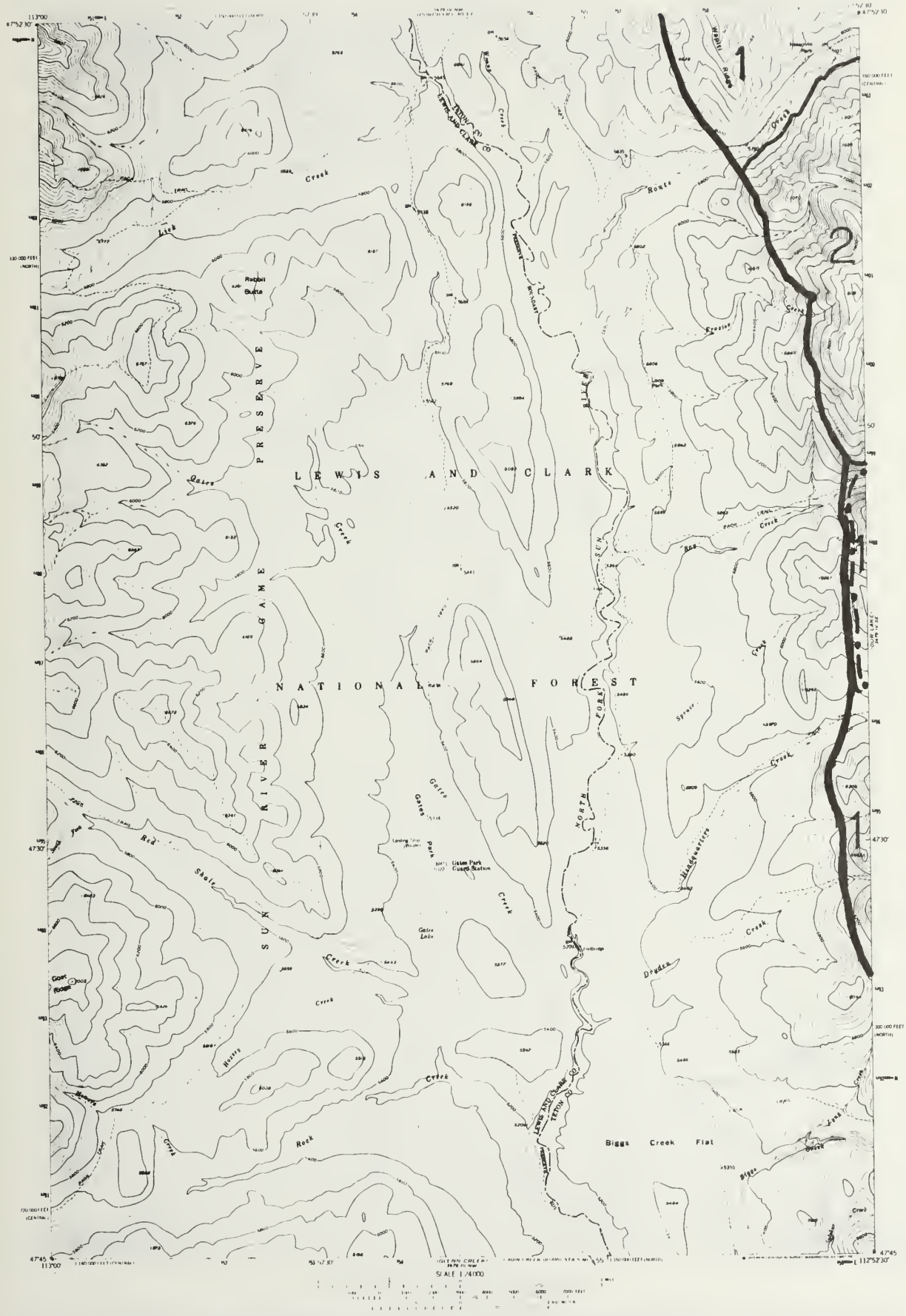


Figure 46. Mountain goat seasonal use areas - Gates Park.

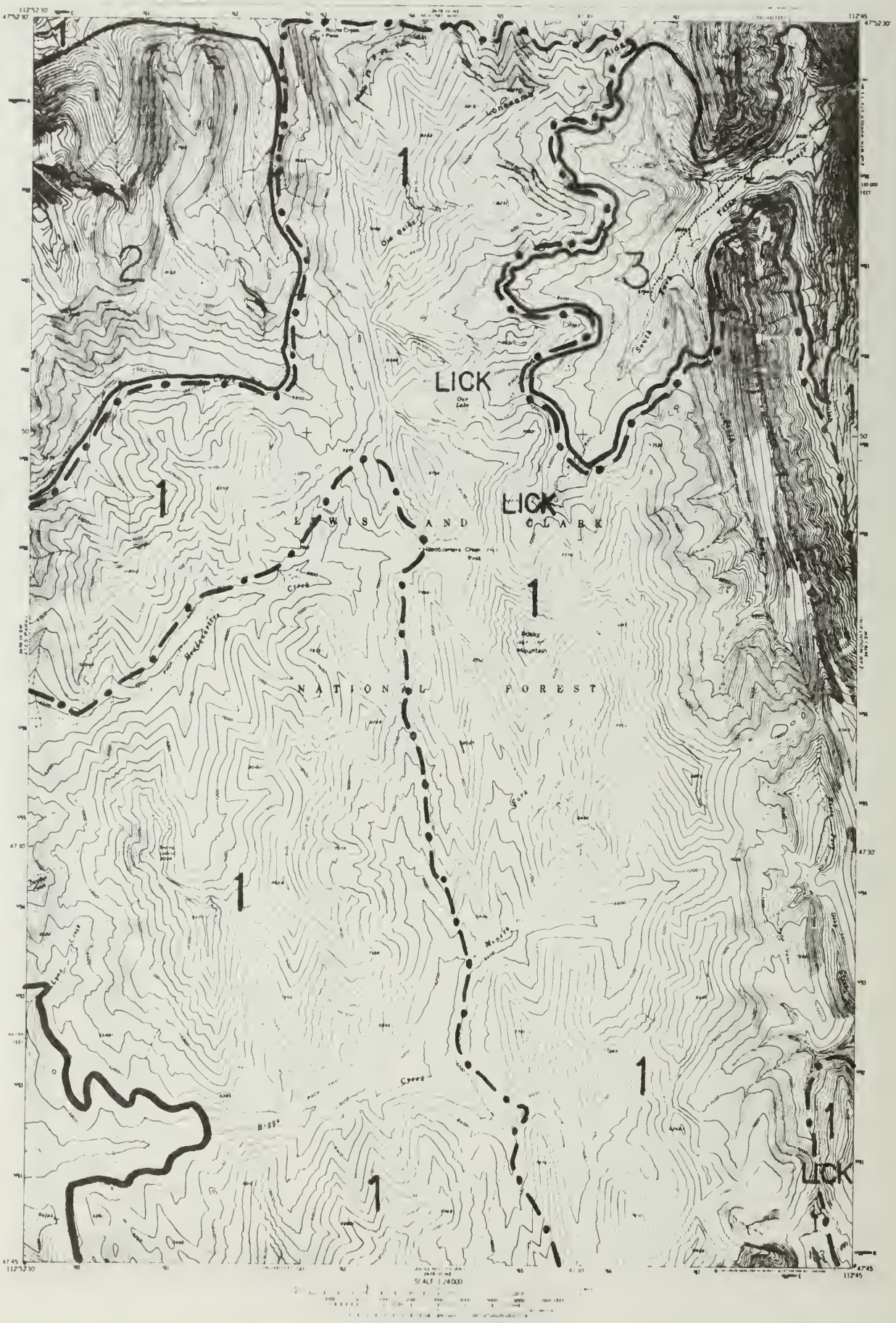


Figure 47. Mountain goat seasonal use areas - Our Lake.

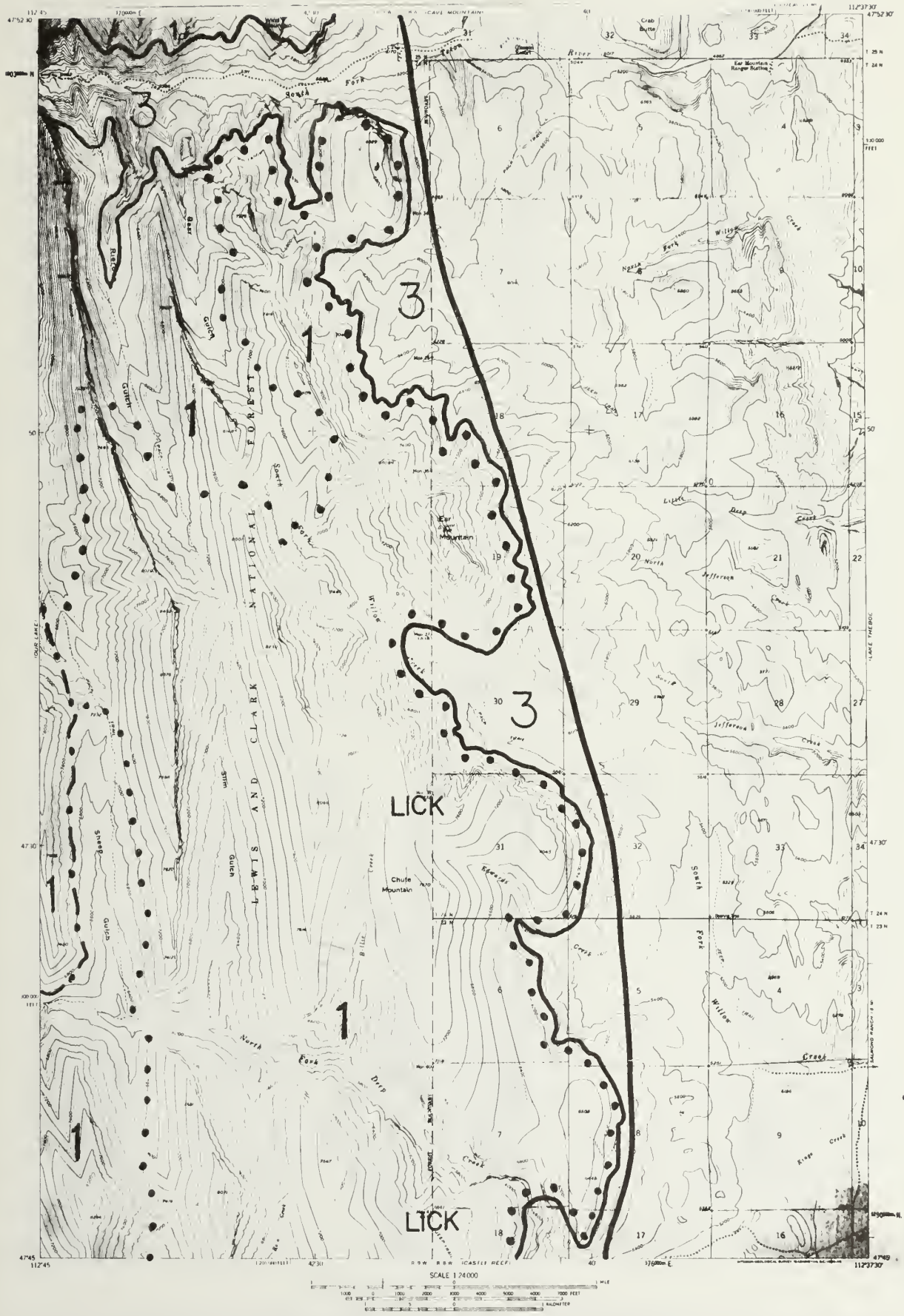


Figure 48. Mountain goat seasonal use areas - Ear Mountain.

1
3
LEWIS AND CLARK
NATIONAL FOREST
Arsenic Peak
Arsenic Ridge
Arsenic Creek
Gibson Reservoir
Gibson Reservoir
Black Trail
Black Trail
Cabin
Cabin
Creek
Creek
Creek

Figure 50. Mountain goat seasonal use areas - Castle Reef.

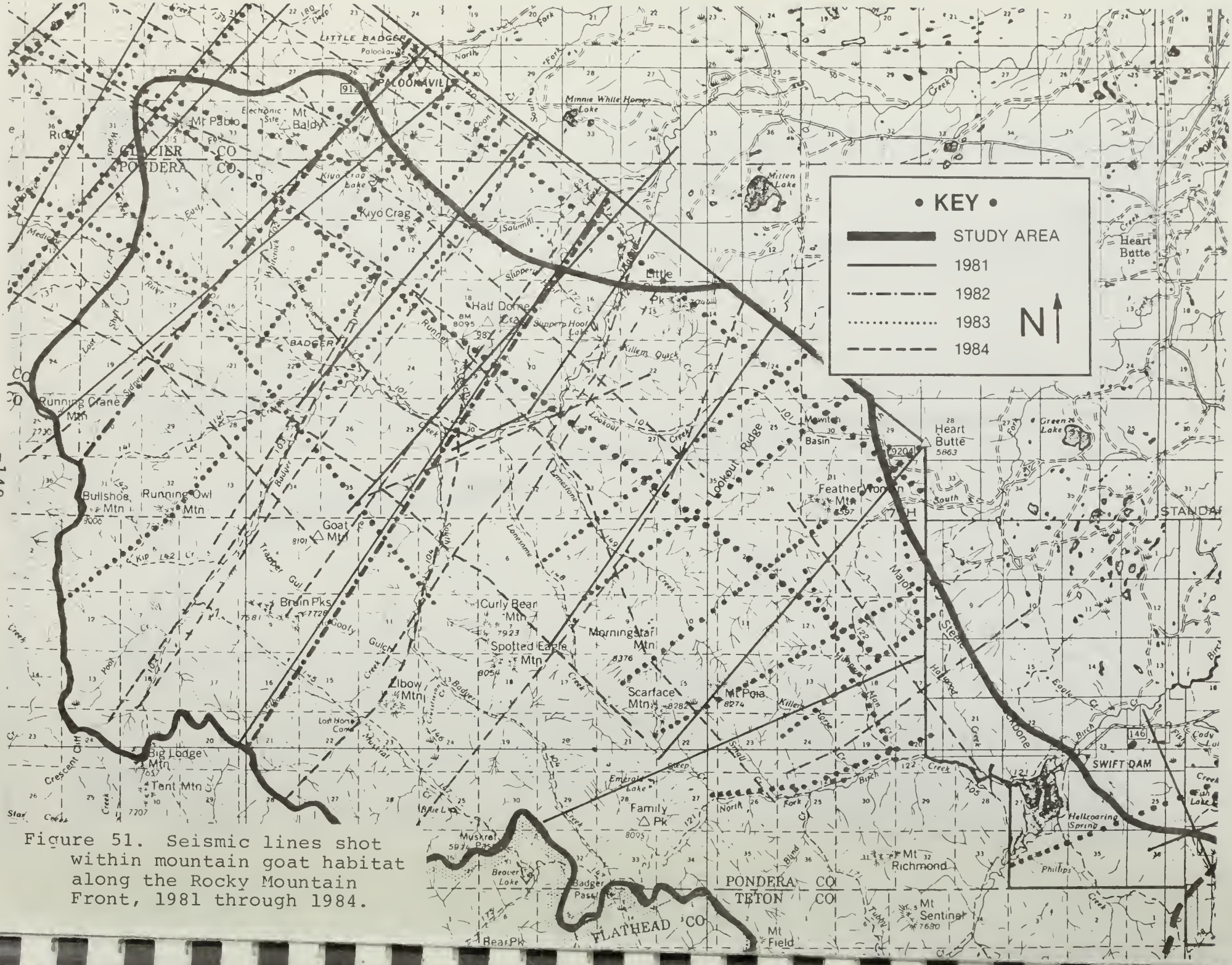


Figure 51. Seismic lines shot within mountain goat habitat along the Rocky Mountain Front, 1981 through 1984.

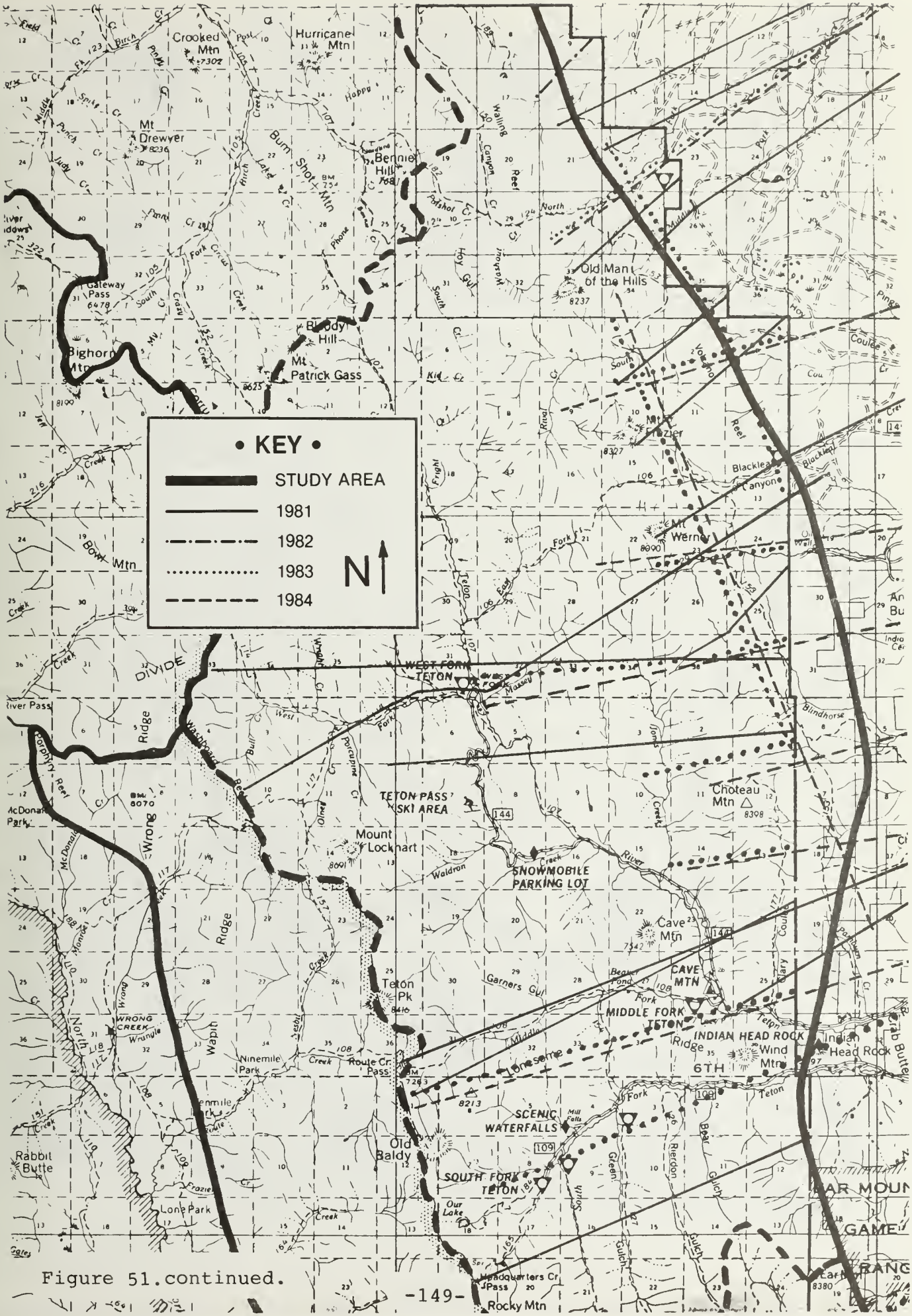


Figure 51.continued.

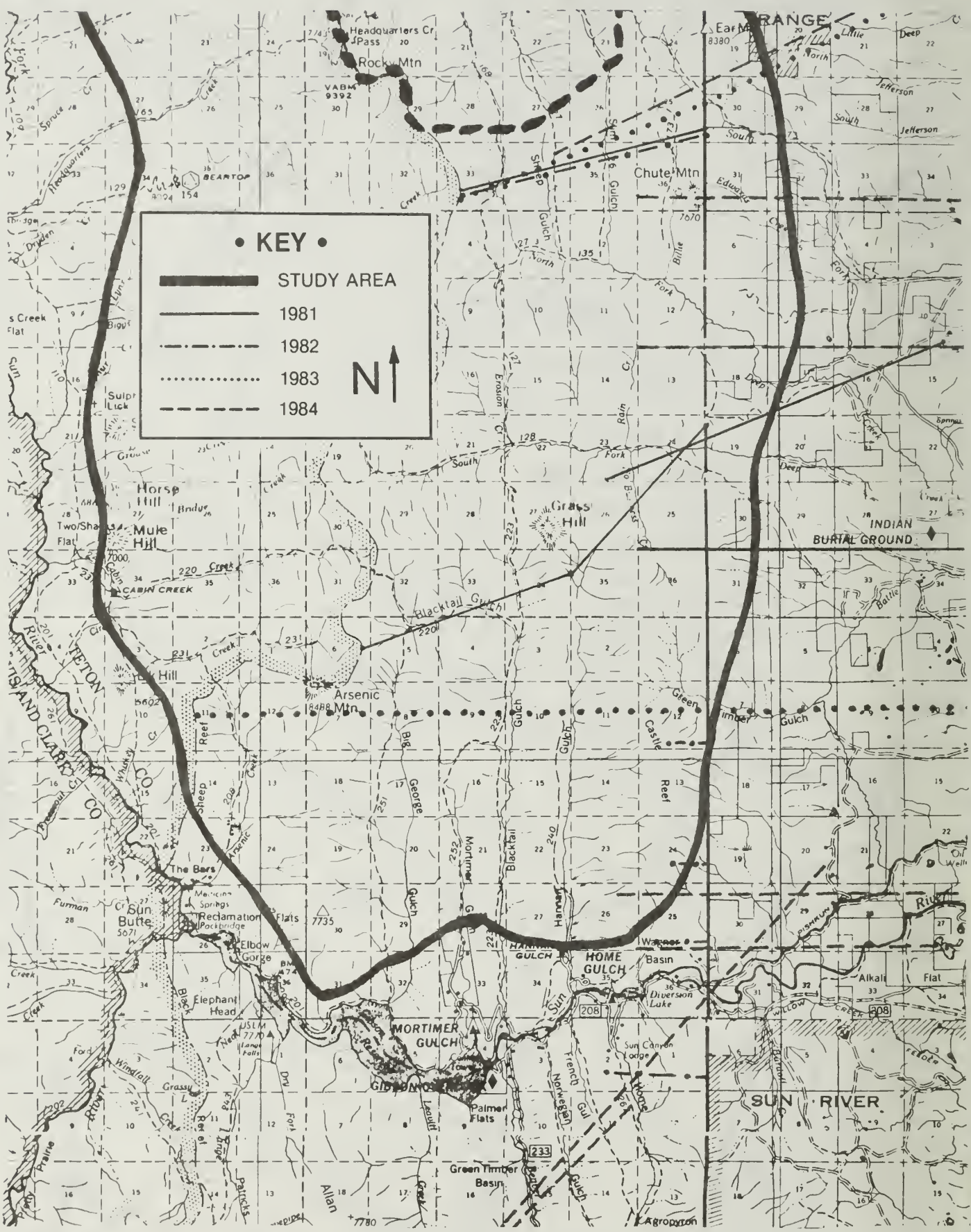
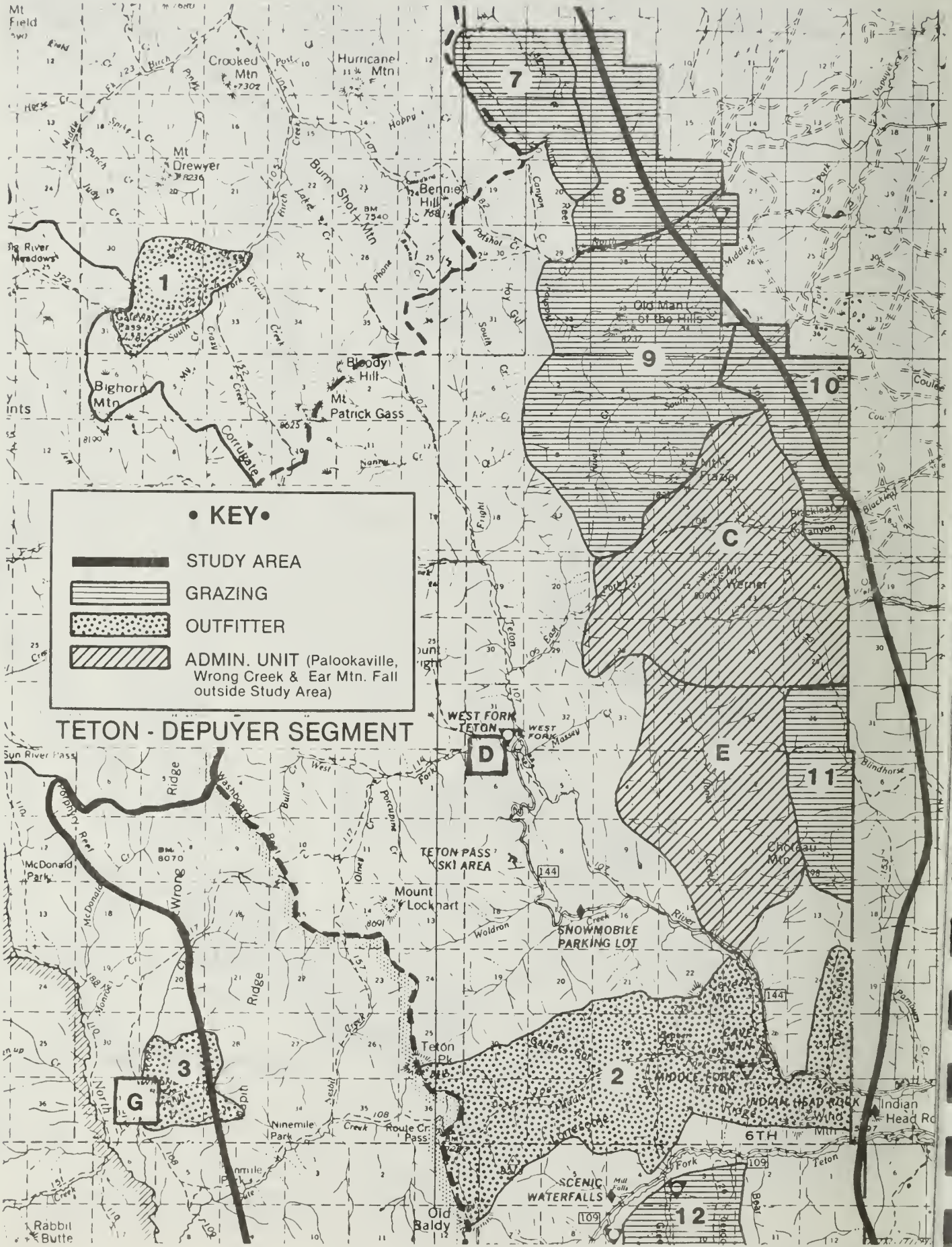


Figure 51. continued.

Figure 52. Forest Service lands grazed by livestock, including livestock grazing allotments, outfitter packstock allotments, and Forest Service administrative units.



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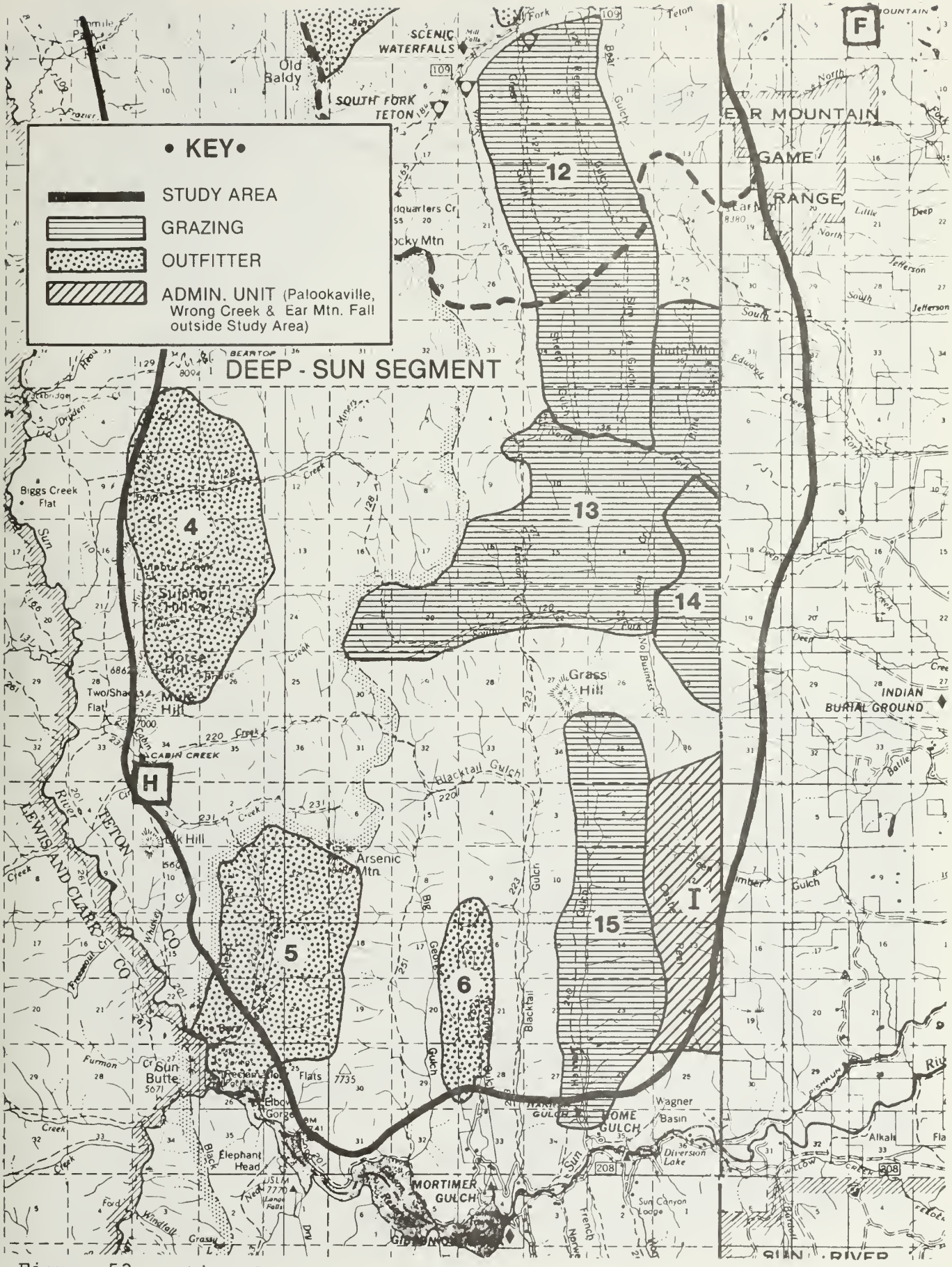
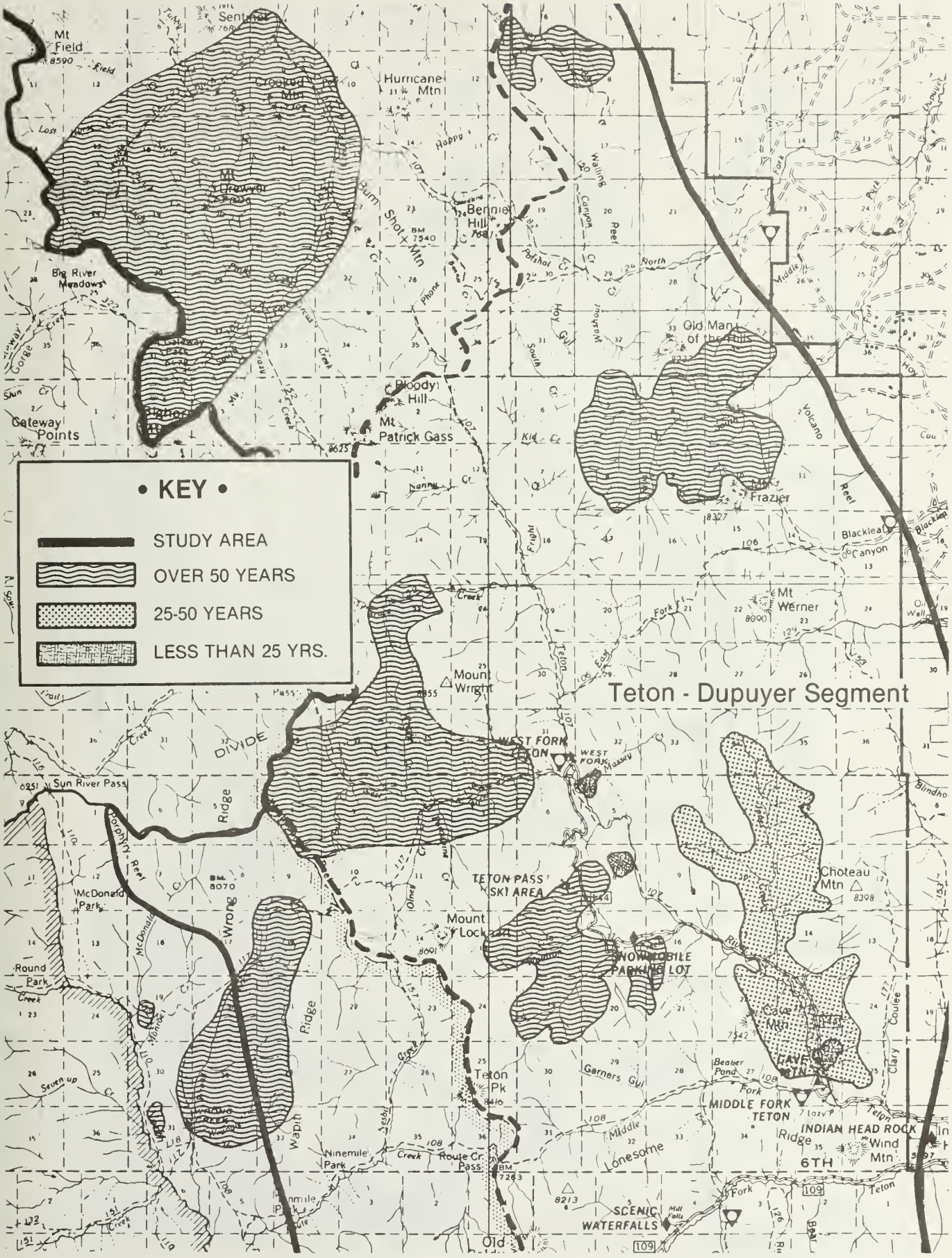


Figure 52.continued.

Figure 53. Natural fires which have occurred within mountain goat habitat along the Rocky Mountain Front.



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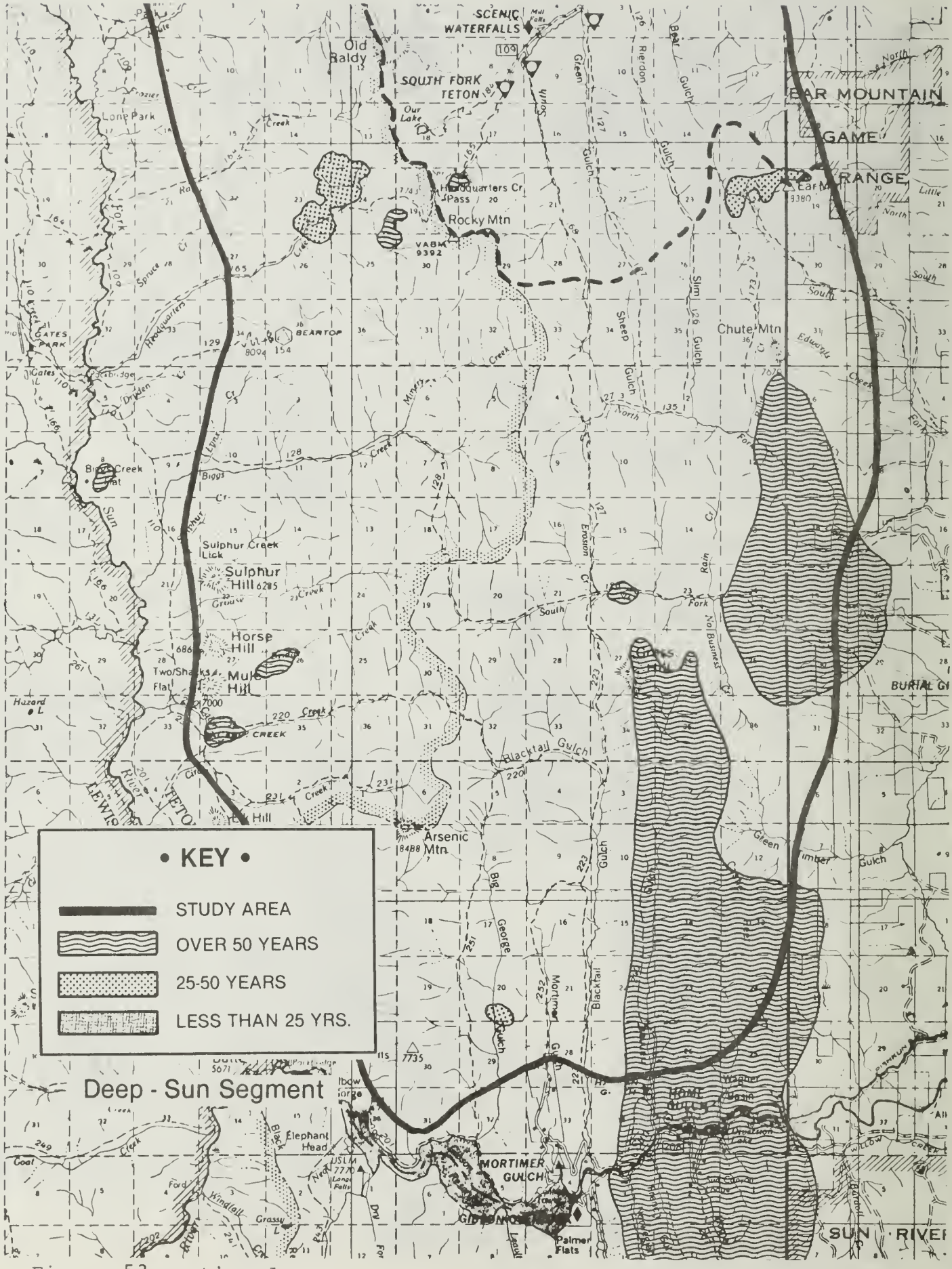

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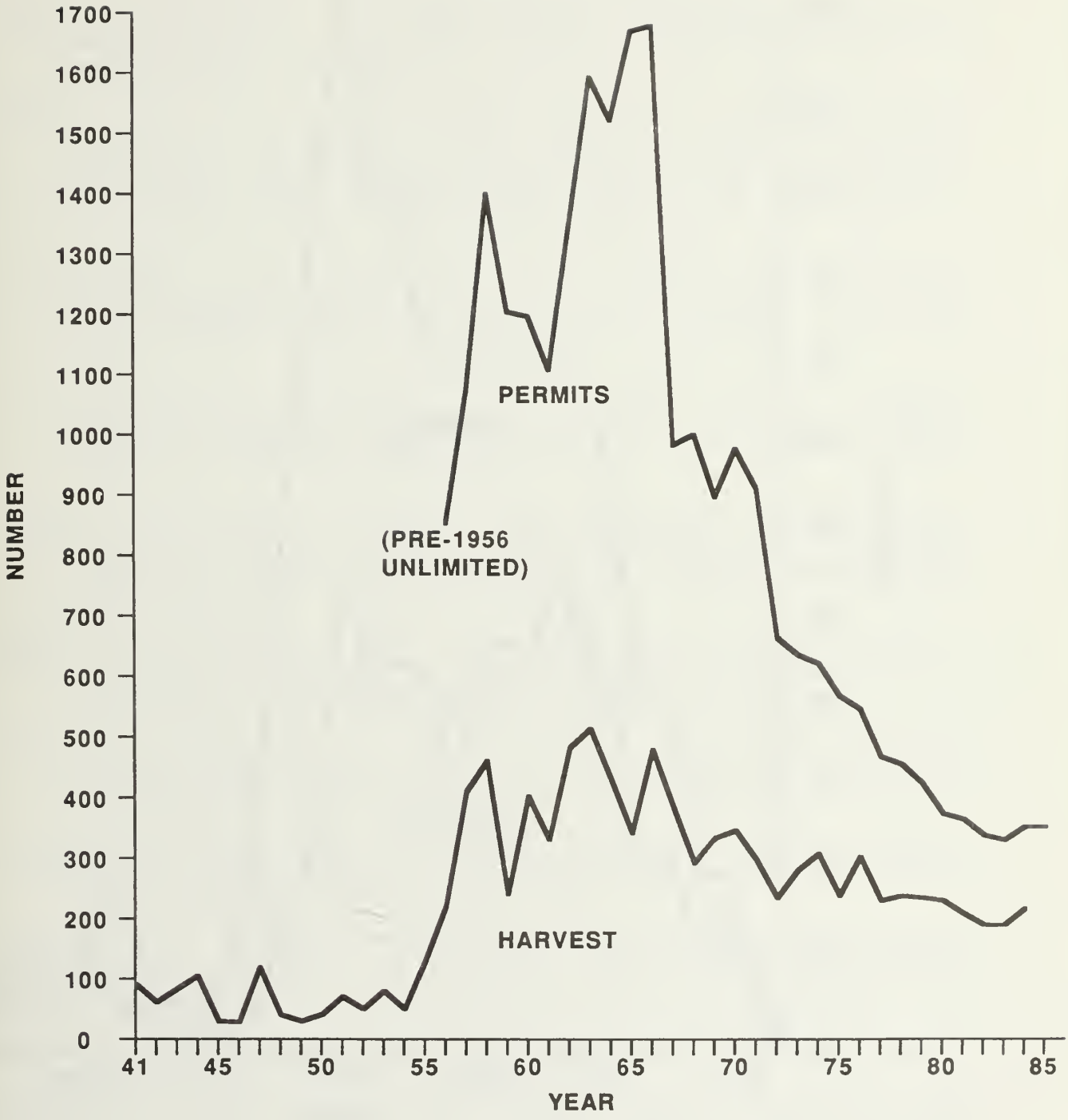

Figure 54. Number of mountain goat permits and goats harvested in Montana, 1941-1985.

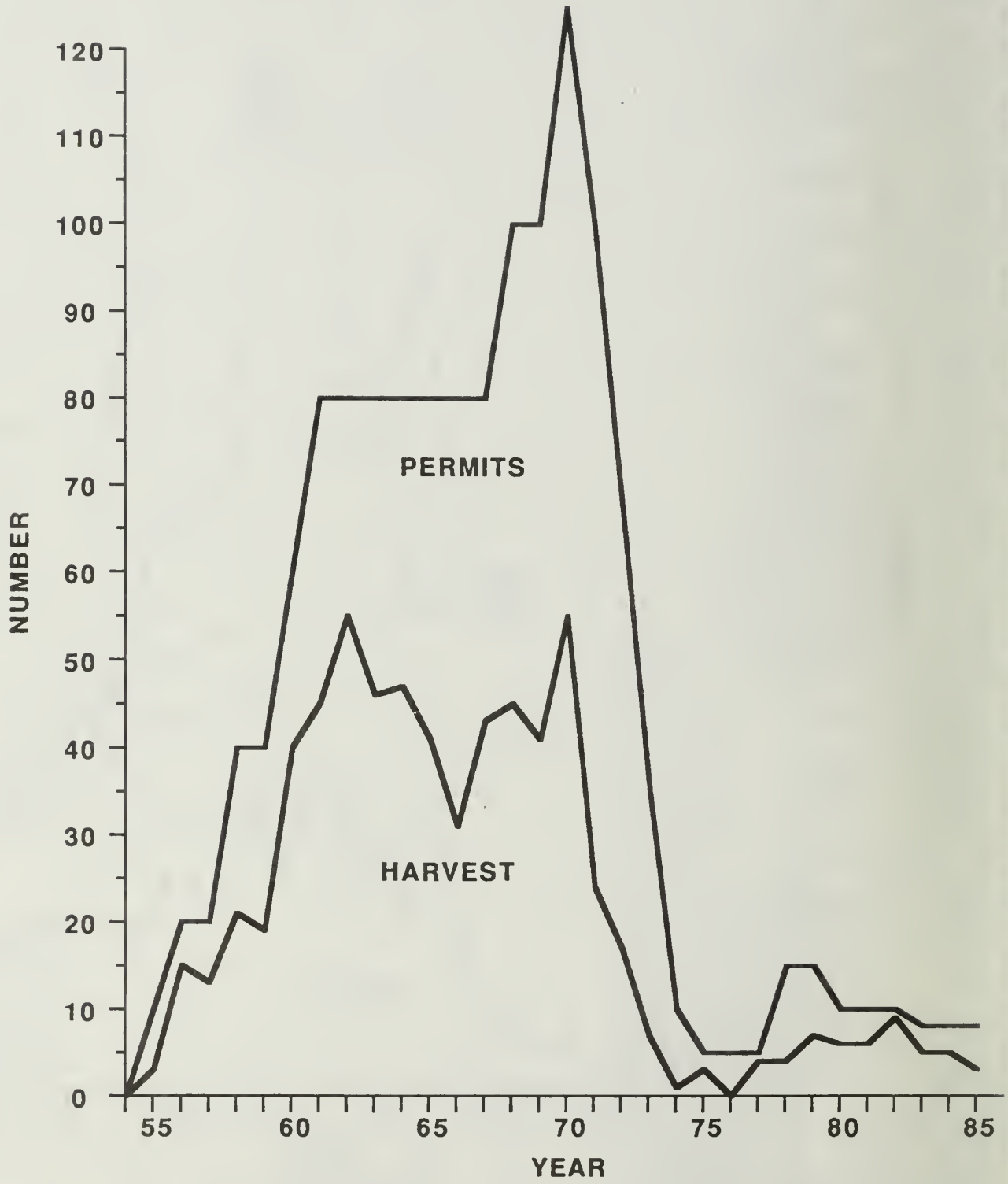

Figure 55. Number of mountain goat permits and goats harvested on the Rocky Mountain Front, 1955-1985.

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Appendix 1. Monthly climatological data from three stations on the Rocky Mountain Front (Blackleaf, East Glacier, Gibson Dam).

m = Insuffient or partial data
t = Trace

Month 1985	Ave. Max. °F	Ave. Min. °F	Ave.	Ppt. Total (in.)	Snow Total (in.)	Max. Depth on Ground (in.)
Dec						
Nov						
Oct	55.6	31.8	43.7m	1.42	m	m
	47.9	29.5	38.7	3.32	30.0	20
	53.0	31.5	42.3	1.58	8.0m	8
Sep	52.6	33.1m	42.9m	4.77	3.0	T
	51.4	31.3m	41.4	5.93	24.0	9
	55.1	35.9	45.5	5.32	0m	0
Aug	71.3	43.6	57.5	4.13	0	0
	68.9	42.1	55.5m	3.23	0	0
	71.6	44.2	57.9	5.19	0	0
Jul	87.5	53.8	70.7	0.10	0.0	0
	80.5	44.3	62.4	0.25	0.0	0
	83.8	50.0	66.9	0.16	0.0	0
Jun	68.9	38.3	53.6	0.30	0.0	0
	67.7	36.4	52.1	1.52	0.0	0
	70.2	41.0	55.6	0.95	0.0	0
May	m	m	m	m	m	m
	65.8m	33.8m	49.8m	3.14	T	T
	67.0	36.7	51.9	1.99	0.0	0
Apr	60.9	33.9m	47.4m	0.75	m	m
	49.6	29.6	39.6	1.93	11.0m	32
	55.6	33.1	44.4	0.64	1.0	1
Mar	45.3	19.5m	32.4m	1.40	6.5m	m
	41.2	14.6	27.9	1.74	30.0m	47
	43.2	20.7	32.0	0.69	23.5	14
Feb	32.9	8.7	20.8	0.56	m	m
	m	m	m	1.85	27.0m	41
	32.2	12.1	22.2	0.53	10.5	13
Jan	36.0m	10.1	23.1m	0.22	m	m
	m	m	m	0.26	4.0m	41
	34.9	11.3	23.1	0.26	3.5	14

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Appendix 1 continued.

Month 1984	Ave. Max. °F	Ave. Min. °F	Ave.	Ppt. Total (in.)	Snow Total (in.)	Max. Depth on Ground (in.)
Dec	23.9m[1/]	-1.5m	11.2m	1.24	23.0	m
	25.0m	0.1	12.6m	4.10	66.0	45
	28.6	8.0	18.3	1.08	22.3	16
Nov	44.5	21.3	32.9	0	0	0
	38.0	22.6	30.3	1.6	10.0	22
	41.9	26.7	34.3	0.07	0.5	3
Oct	50.5	22.2m	36.4m	1.13	6.0	0
	m	m	m	3.97	47.0m	24
	49.9	25.9	37.9	1.02	16.0	7
Sep	m	34.9	m	1.22	0m	0
	55.0	31.6	43.3	4.08	16.0	10
	62.4	34.7	48.6	2.37	2.0m	14
Aug	84.8m	46.5m	65.7m	0.52	0	0
	78.7	44.6	61.7	1.09	0	0
	81.4	47.5	64.5	1.79	0	0
Jul	84.6	47.7	66.2	0.66	0	0
	75.3	44.7	60.0	0.59	0	0
	79.2	48.1	63.7	0.28	0	0
Jun	72.0	42.9	57.5	1.45	0	0
	65.3	39.7	52.5	3.41	0	0
	68.1	42.1	55.1	3.39	0	0
May	63.4	35.1	49.3	0.83	0	0
	56.9	34.5	45.7	1.96	3.5	T
	60.2	37.4	48.8	1.08	0	0
Apr	56.8	25.3	41.1	2.39	0m	0
	48.1	27.4m	37.8m	2.66	5.5	3
	50.5	29.2	39.9	3.33	4.0	3
Mar	44.3	22.2	33.3	0.22	m	m
	43.1	19.8	31.5	1.30	16.0m	8
	43.3	24.0	33.7	0.8	5.0	3
Feb	51.6	27.1	39.4	0.05	m	m
	40.6	25.8	33.2	0.41	6.0	5
	45.1	27.4	36.3	0.01	0.5	T
Jan	43.1	15.8m	29.5m	0.67	12.0m	m
	34.4	17.9	26.2	1.88	10.0	13
	39.6	22.1	30.9	0.68	5.0	4

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Appendix 1 continued.

Month 1983	Ave. Max. °F	Ave. Min. °F	Ave.	Ppt. Total (in.)	Snow Total (in.)	Max. Depth on Ground (in.)
Dec	16.8	-10.3	3.3	0.64	5.0m	m
	17.2	-7.1	5.1	1.50	21.0	17
	20.3	-1.8	9.3	0.41	8.1	6
Nov	44.8	22.8	33.8	0.53	8.0m	0
	39.4	23.8	31.6	2.11	15.0m	7
	m	m	m	-	m	m
Oct	61.8	29.4	45.6	0.02	0	0
	53.8	32.7	43.3	0.39	0	0
	58.5	35.3	46.9	0.07	0	0
Sept	66.9	36.8	51.9	1.41	m	m
	59.1m	35.3	47.2m	2.28	9.0m	5
	63.6	38.2	50.9	1.17	6.0	4
Aug	86.0	53.1	69.6	0.35	0	0
	78.6	46.8	62.7	0.44	0	0
	81.9	49.5	65.7	1.66	0	0
July	m	m	m	-	m	m
	69.5	44.7	57.1	2.32	0	0
	74.8	46.9	60.9	1.87	0	0
June	69.6	42.3	56.0	1.63	0	0
	64.7	40.9	52.8	2.57	0	0
	68.6	43.3	56.0	3.76	0	0
May	m	m	m	-	m	m
	57.9	33.8	45.9	0.86	2.0	2
	60.9	34.0	47.5	1.96	10.0	10
Apr	52.4	24.8	38.6	0.19	m	0
	50.9	25.7	38.3m	0.38	m	21
	50.2	26.6	38.4	0.61	3.0	3
March	44.5	22.5	33.5	0.98	m	m
	41.5	20.6	31.1	2.29	17.0	25
	43.9	23.8	33.9	2.03	21.5	19
Feb	46.8	21.8	34.3	0.18	1.0m	m
	39.9	23.4	31.7	1.07	3.0m	20
	44.5	25.2	34.9	0.09	.5	1
Jan	m	m	m	-	m	m
	37.2	18.1	27.7	3.32	25.2	26
	42.4	23.5	33.0	0.49	.2	t

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Appendix 1 continued.

Month 1982	Ave. Max. °F	Ave. Min. °F	Ave.	Ppt. Total (in.)	Snow Total (in.)	Max. Depth on Ground (in.)
Dec	36.4	13.9	25.2	0.26	4.0	-
	31.2	15.6	23.4	2.89	28.0	20
	35.6	19.9	27.8	0.55	8.0	3
Nov	39.2	12.9	26.1	0.37	4.0	-
	33.3	14.8	24.1	2.40	29.0	18
	39.4	19.6	29.5	0.55	11.0	6
Oct	60.1	29.1	44.6	-	-	-
	50.2	29.5	39.9	0.49	2.0	2
	56.2	33.2	44.7	0.21	0.5	0
Sept	68.6	36.9	52.8	1.84	2.0	0
	60.9	37.7	49.3	1.79	6.0	4
	65.1	39.1	52.1	2.63	m	m
Aug	81.8	46.7	64.3	0.89	0	0
	72.6	43.1	57.9	0.94	0	0
	77.7	47.0	62.4	0.86	0	0
Jul	77.2	48.5	62.9	0.69	0	0
	71.7	44.3	58.0	0.57	0	0
	75.2	47.3	61.3	0.86	0	0
Jun	70.2	44.6	57.4	3.51	0	0
	68.6	38.8	53.7	1.88	t	t
	68.9	42.8	55.9	2.33	0	0
May	61.8	31.1	46.5	3.19	8.0	t
	55.1	30.1	42.6	2.81	12.0	29
	59.4	32.8	46.1	1.45	3.0	3
Apr	49.9	23.1	36.5	0.35	4.5	t
	42.8	19.9	31.4	1.61	30.0	47
	46.9	24.4	35.7	0.92	11.0	12
Mar	38.0	15.4	26.7	0.92	18.0	
	39.3	12.3	25.8	3.14	37.0	45
	40.0	20.4	30.2	1.61	23.5	18
Feb	35.0	6.9	21.0	0.65	4.5	
	29.5	8.7	19.1	3.87	18.0	33
	33.9	12.1	23.0	1.91	13.5	10
Jan	16.2	-6.4	4.9	1.0	17.0	
	19.9	-4.4	7.8	4.57	63.0	33
	28.2	4.4	16.3	1.39	22.8	11

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Appendix 1 continued.

Month 1981	Ave. Max. °F	Ave. Min. °F	Ave.	Ppt. Total (in.)	Snow Total (in.)	Max. Depth on Ground (in.)
Dec	33.5	11.6m	22.6m	0.28	-	-
	31.2m	13.3m	22.3m	2.97	18.0	12
	33.3	16.8	25.1	0.94	7.5	5
Nov	m	m	m	0.10	1.0	-
	44.3m	26.6m	35.5m	1.72	13.0	9
	48.3	27.8	38.1	0.20	1.0	1
Oct	56.2	32.8	44.5	1.12	7.0	-
	49.6	27.4	38.5	0.96	8.0	-
	53.5	31.6	42.6	1.12	0	-
Sept	72.3	39.2	55.8	0.20	0	0
	65.3	35.2	50.3	0.36	0	0
	70.7	39.3	55.0	0.49	0	0
Aug	83.5	48.4	66.0	2.21	0	0
	78.2	41.7	60.0	0.74	0	0
	80.7	46.0	63.4	1.59	0	0
Jul	79.4	47.1	63.3	1.21	0	0
	72.3	43.5	57.9	1.50	0	0
	77.3	46.4	61.9	1.88	0	0
Jun	-	-	-	-	-	-
	62.4	38.9	50.7	2.21	0	0
	64.8	41.3	53.1	1.62	0	0
May	-	-	-	-	-	-
	-	-	-	-	-	-
	58.7	38.8	48.8	6.97	0	0
April	57.6	28.5	43.1	t	t	0
	-	-	-	-	-	-
	53.3	32.1	42.7	0.26	0	0
Mar	50.8	21.2	36.0	2.29	-	-
	-	-	-	-	-	-
	48.6	24.2	36.4	0.83	-	1
Feb	-	-	-	-	-	-
	-	-	-	-	-	-
	39.8	20.2	30.0	0.68	11.0	7
Jan	45.2	18.9	32.1	0.33	-	-
	-	-	-	-	-	-
	42.3	21.8	32.1	0.16	3.7	3

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Appendix 1 continued.

Month 1980	Ave. Max. °F	Ave. Min. °F	Ave.	Ppt. Total (in.)	Snow Total (in.)	Max. Depth on Ground (in.)
Dec	33.2	4.7	19.0	0.62	11.0	-
	-	-	-	-	-	-
	36.8	16.4	26.6	1.12	9.5	7
Nov	-	-	-	-	-	-
	-	-	-	-	-	-
	46.5	26.8	36.7	0.46	4.5	3
Oct	61.6	31.5	46.6	1.37	3.0	-
	-	-	-	-	-	-
	59.6	33.9	46.8	1.30	-	2
Sept	67.0	39.2	53.1	1.12	1.0	0
	-	-	-	-	-	-
	66.9	42.3	54.6	1.37	0	0
Aug	71.4	42.8	57.1	1.41	0	0
	-	-	-	-	-	-
	70.8	43.2	57.0	1.03	0	0
Jul	80.3	49.3	64.8	0.24	0	0
	-	-	-	-	-	-
	77.7	46.8	62.3	0.67	0	0
Jun	-	-	-	-	-	-
	-	-	-	-	-	-
	67.0	41.9	54.5	5.17	0	0
May	65.4	39.1	52.3	4.04	t	0
	-	-	-	-	-	-
	64.1	38.1	51.1	6.09	0	0
April	58.8	31.2	45.0	2.10	25.0	0
	-	-	-	-	-	-
	60.1	30.8	45.5	2.30	14.0	14
March	37.9	17.1	27.5	0.87	-	-
	-	-	-	-	-	-
	39.1	20.9	30.0	0.46	5.2	4
Feb	37.5	15.8	26.7	0.82	-	-
	-	-	-	-	-	-
	40.1	18.2	29.2	0.82	18.0	11
Jan	24.7	1.0	12.9	0.97	12.5	-
	-	-	-	-	-	-
	28.5	3.1	15.8	1.27	16.8	13

1/ Incomplete data for month.

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Appendix 2. °F Annual climatological data from three stations on the Rocky Mountain Front (Blackleaf, East Glacier, Gibson Dam).

Year	°F Max	°F Min	Ave.	Ppt (in.)
1984	98	-24	-	10.38
	92	-23	-	27.05
	94	-20	42.7	3.39
1983	101	-41	42.3	11.15
	90	-42	39.5	19.53
	96	-39	42.6	14.79
1982	90	-30	39.1	-
	85	-33	36.1	26.96
	86	-28	40.4	15.27
1981	96	-35	32.1	13.76
	89	-	-	20.41
	94	-29	32.1	16.74
1980	91	-28	-	18.16
	-	-	-	32.74
	92	-29	42.5	22.06
1979	92	-34	41.6	7.89
	-	-	-	-
	92	-20	41.9	10.68
1978	91	-28	40.9	18.40
	-	-	-	29.87
	89	-34	40.5	17.59
1977	90	-31	41.8	13.44
	-	-	-	27.22
	88	-26	42.1	16.18
1976	92	-24	44.1	15.46
	-	-	-	-
	91	-26	43.6	13.26
1975	93	-25	39.1	25.35
	-	-	-	43.72
	92	-22	39.8	27.36
1974	94	-29	42.8	11.0
	-	-	-	15.31
	89	-24	43.6	24.44
1973	99	-20	42.5	5.27
	-	-	-	17.21
	96	-22	42.6	8.11
1972	89	-42	38.9	16.42
	-	-	-	42.03
	89	-34	40.4	17.70
1971	93	-40	-	11.68
	-	-	-	35.94
	91	-25	41.2	20.03
1970	-	-25	41.0	16.47
	-	-	-	34.66
	91	-35	-	18.84

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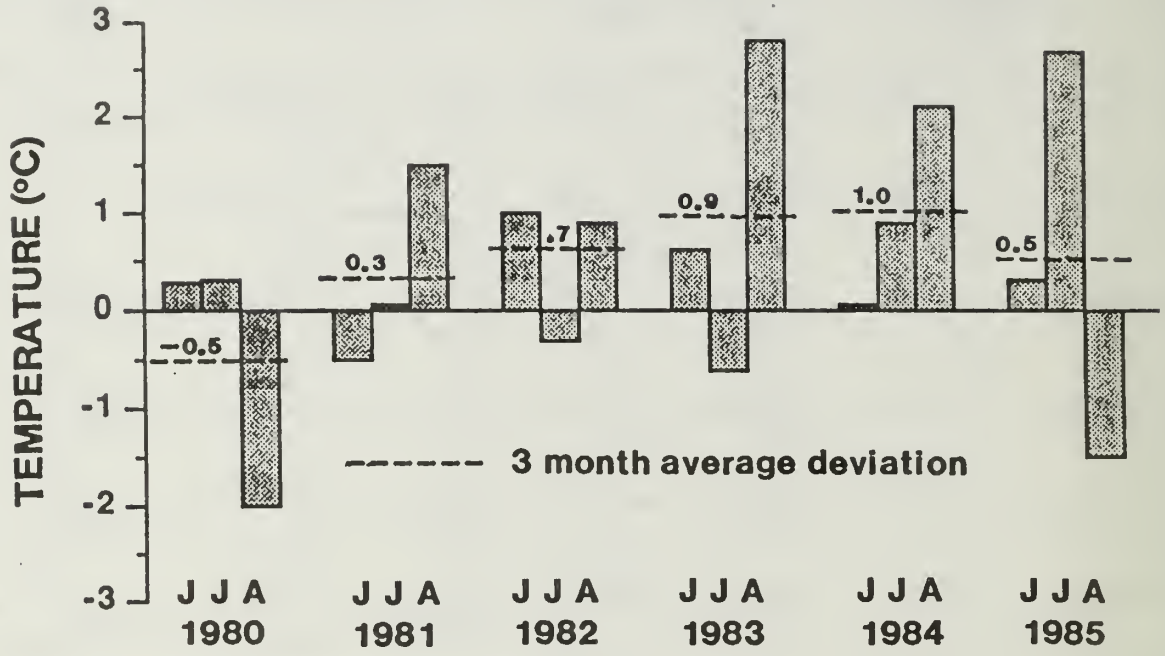
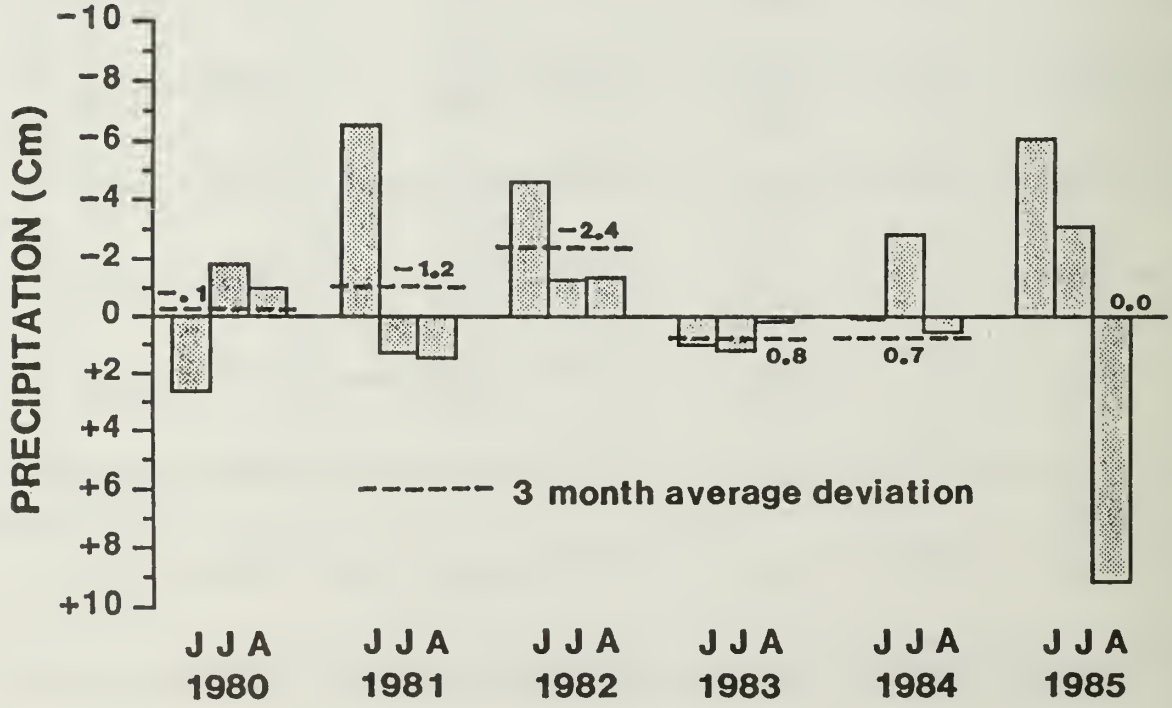
Appendix 3. Deviation from normal temberature and precipitation during June, July, and August at Gibson Dam.





Appendix 4. Mountain goat observation form.

Appendix 5. Codes for mountain goat observation form.

Column		Column	
1-4	Goat ID No.	47	Clouds 1 = clear 2 = ptly cloudy 3 = mostly cloudy 4 = overcast
5-10	Day, month, year	48	Wind - Beaufort numbers code MPH indicators 0 = 1 smoke rises vertically 1 = 1-3 smoke drifts 2 = 4-7 leaves rustle 3 = 8-12 leaves/twigs in constant motion 4 = 13-18 raises dust & loose paper 5 = 19-24 small trees in leaf, sway 6 = 25-31 large branches in motion 7 = 32-38 whole trees in motion 8 = 39-46 breaks twigs off trees 9 = over 47 structural damage
11-14	Military time		
15	Zone 2		
16-26	UTM - universal transverse mercator		
27-28	Total no. goats observed		
29	Adult males		
30	Adult females	49	Precipitation type 0 = none 1 = rain 2 - hail or sleet 3 = snow
31-32	Unclassified adults (sex)	50	Precipitation rate 0 = none 1 = light 2 = moderate 3 = heavy
33	Yearlings	51	Type observation 1 = air 2 = ground
34	Two-year-olds	52	Ground condition 1 = dry 2 = damp 3 = wet, muddy 4 - scattered snow 5 = snow 6" 6 = snow 6-12" 7 = snow 12"
35-36	Unclassified subadults (age)		
37	Kids		
		53	
38-39	Unclassified goats (age & sex)	54-55	Observers initials
40-41	Drainage code	56	Data missing. If a 1 is entered computer will not consider entry.
42-44	Land type	57-58	Elevation. Eg:7800 = 78
45	Goat seen (1) or not seen (0)	59	Code data: 1 = prevented from locating, 2 = no attempt to locate, 3 = tried to locate but unsuccessful, 4 = goat dead or collar retrieved, 5 = nonspecific signal-could not pin down. (Enter code here if a 1 is entered in Col. 56).
46	Degrees F° 3 = 20-40 1 = less than 0 4 = 40-60 2 = 0-20 6 = over 80		

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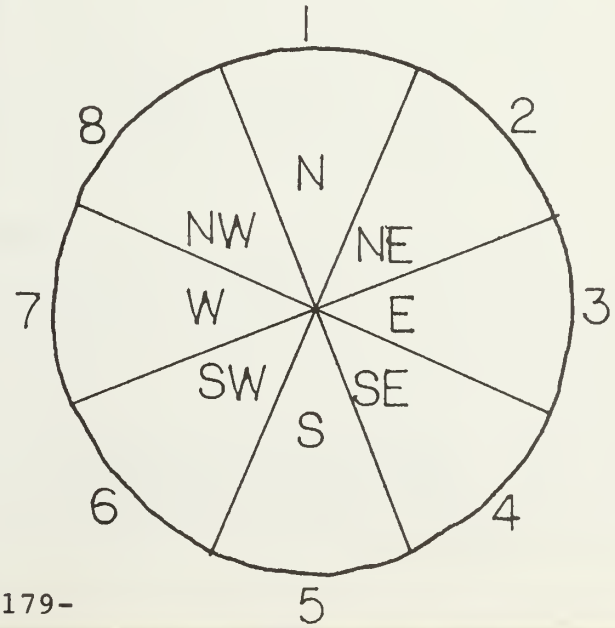
Appendix 5. continued.

Column		Column	
60-61	Slope 1= > 90% 2= 70-90% 3= 30-70% 4= 9-30% 5= < 8%	67-68	Vegetation Type 1 crust 2 tundra 3 krummholz 4 short grass 5 parkland 6 forest 7 open 8 brush
62	Distance to escape terrain* 1 10 m 2 10-50 m 3 50-100 m 4 over 100 m (*cliffs, bluffs, cirque basins, broken)	69	Aspect 1 N 2 NE 3 E 4 SE 5 S 6 SW 7 W 8 NW 9 flat
63	Distance to timber 1 10 m 2 10-50 m 3 50-100 m 4 over 100 m		
64	Distance to road 1 = ¼ mi 2 = ¼ - ½ mi 3 = ½ - 1 mi 1 = over 1 mi		
65-66	Terrain Type 1 bluffs 2 cliffs 3 cirque basin 4 talus slope 5 broken 6 ridge 7 park 8 creek 9 sidehill		



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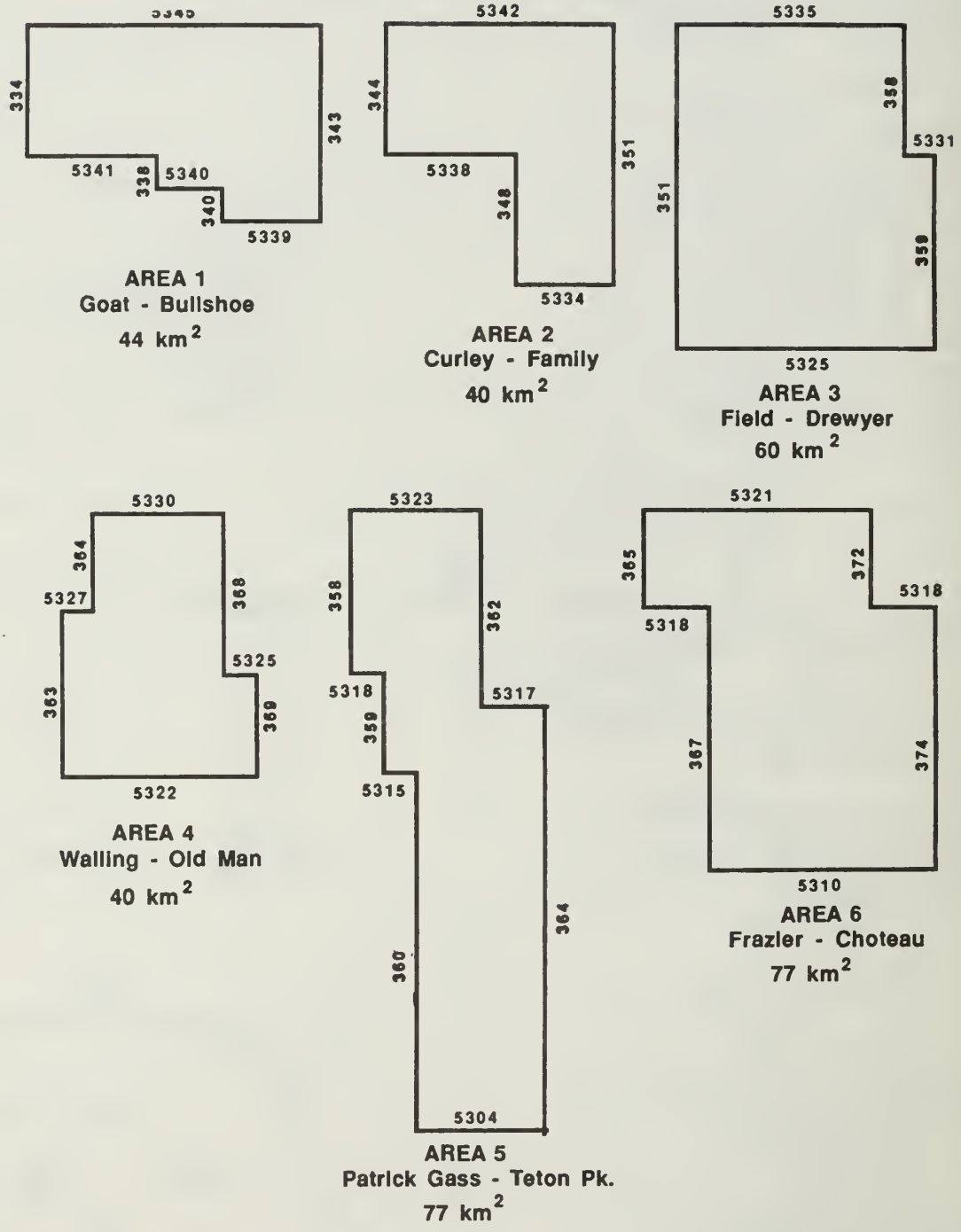
Appendix 6. UTM Coordinates for mountain goat concentration areas along Rocky Mountain Front.



Appendix 7. Frequency distribution in percent, of major land types occurring on mountain goat use areas along the Rocky Mountain Front.

Land Type	RMF	North	Center	South	Conc. Areas Total	Conc. Areas North	Conc. Areas Center	HD415	HD414
14D	-	-	-	-	-	-	-	-	-
18	-	-	-	8.7	-	5.3	-	9.6	-
25	6.2	8.6	-	-	-	6.4	-	11.7	-
25C	-	8.3	-	-	-	8.6	-	15.2	-
71	7.1	-	9.0	7.9	-	-	5.9	5.1	-
181	-	5.9	-	-	-	-	-	8.1	-
182	10.3	16.4	10.0	-	7.6	-	10.1	8.1	7.4
202	14.8	14.7	14.8	14.8	18.1	21.7	15.1	38.6	11.4
Vc	-	-	-	9.3	-	-	-	-	-
VI	18.4	18.6	22.7	13.3	36.0	34.5	37.2	-	47.7
VIIa	-	5.8	-	-	8.2	9.7	7.0	-	10.9
VIII	-	-	-	8.6	-	-	-	-	-
Ø	6.2	-	8.4	8.5	-	-	-	-	-

	Concentration						Other land types occurring at frequencies of less than 5%		
	Area A	Area B	Area C	Area D	Area E	Area F			
14D	-	-	-	11.5	-	-	12	161	VII
18	9.3	10.0	-	-	-	-	13a	170	VIII
25	11.2	12.2	-	-	-	-	17	171	Ve
25C	5.6	26.7	-	-	-	-	20	172	V
71	9.3	-	-	-	6.5	8.2	20a	177	
181	15.0	-	-	-	8.3	-	21b	183	
182	5.6	11.1	-	-	-	26.3	22	200	
202	37.4	40.0	-	7.7	14.2	20.5	23a	201	
Vc	-	-	-	-	-	-	24	I	
VI	-	-	76.5	65.4	31.4	25.7	25b	Ib	
VIIa	-	-	21.6	7.7	11.8	-	30	II	
VIII	-	-	-	-	-	-	42	III	
Ø	-	-	-	-	-	5.3	71a	IIIa	
							71b	Va	
							72	Vb	
							160	Vd	

See Appendix 6 for locations of areas.

Appendix 8. Frequency distribution in percent, of photointerpretation types occurring on mountain goat use areas along the Rocky Mountain Front.

Photointerpretation Types	RMF	North	Center	South	Conc. Areas Total	Conc. Areas North	Conc. Areas Center	HD415	HD414
Nontimber	55.9	49.7	57.7	67.6	66.4	62.7	69.8	55.8	70.2
Poorly Stocked	10.6	14.4	9.0	4.4	8.9	10.6	7.3	8.6	9.0
Med-Well Stocked	33.5	35.9	33.3	27.9	24.7	26.6	22.9	35.6	20.8
Unknown[1/]	(20.8)	(4.7)	(13.6)	(50.2)	(6.1)	(0.6)	(10.6)	(-)	(8.1)

	Concentration					
	Area A	Area B	Area C	Area D	Area E	Area F
Nontimber	58.8	52.3	71.3	80.8	55.0	74.7
Poorly Stocked	8.4	8.9	13.1	4.9	10.6	6.2
Med-Well Stocked	32.7	38.9	15.6	14.5	34.4	19.1
Unknown[1/]	(-)	(-)	(1.2)	(-)	(22.5)	(5.3)

[1/] Unknown - a portion (%) of the area was not categorized according to PI type if it occurred in wilderness.

See Appendix 6 for locations of areas.

Appendix 9. Frequency distribution in percent, of topography categories occurring on mountain goat use areas along the Rocky Mountain Front.

Topography	RMF	North	Center	South	Conc. Areas Total	Conc. Areas North	Conc. Areas Center	HD415	HD414
Ridge	4.3	5.5	3.2	4.1	4.1	4.2	4.1	3.0	4.5
Upper Slope	18.3	15.2	19.7	19.7	23.4	17.5	28.2	14.7	26.2
Mid Slope	50.9	42.0	58.5	53.9	54.3	52.4	55.9	48.2	56.3
Lower Slope	18.2	23.8	12.5	17.5	12.2	17.0	8.3	20.8	9.4
Bench/Flat	2.5	5.1	0.9	0.7	1.2	1.7	0.9	3.0	0.7
Stream Bottom	6.0	8.3	5.2	4.1	4.7	7.2	2.7	10.2	3.0

	Concentration					
	Area A	Area B	Area C	Area D	Area E	Area F
Ridge	1.9	4.4	5.6	5.8	4.1	2.9
Upper Slope	18.7	10.0	21.0	18.3	36.1	26.3
Mid Slope	53.3	42.2	57.4	70.2	43.8	59.1
Lower Slope	20.6	21.1	12.3	5.8	11.8	6.4
Bench/Flat	2.8	3.3	-	-	-	2.3
Stream Bottom	2.8	18.9	3.7	-	4.1	2.9

See Appendix 6 for locations of areas.

Appendix 10. Frequency distribution in percent, of increments of elevation occurring on mountain goat use areas along the Rocky Mountain Front.

Elevation (m)	RMF	North	Center	South	Conc. Areas Total	Conc. Areas North	Conc. Areas Center	HD415	HD414
1372	1.1	2.1	-	1.0	-	-	-	-	-
1525	5.5	7.7	3.9	4.4	1.1	2.2	0.2	1.5	1.0
1677	14.6	19.5	12.6	10.7	8.3	13.4	4.3	12.7	6.9
1830	27.0	30.9	27.7	21.0	24.3	27.0	22.1	27.9	23.1
1982	23.1	21.3	24.1	24.4	27.0	25.3	28.4	26.9	27.1
2135	18.9	14.7	20.6	22.4	26.0	22.6	28.8	20.8	27.7
2287	7.9	3.3	8.4	13.2	10.6	8.1	12.6	8.6	11.2
2440	1.6	0.4	2.2	2.4	2.5	1.4	3.4	1.5	2.8
2592	0.3	-	0.5	0.5	0.1	-	0.2	-	0.2

	Concentration					
	Area A	Area B	Area C	Area D	Area E	Area F
1372	-	-	-	-	-	-
1525	-	3.3	3.1	1.0	-	-
1677	12.1	13.3	14.2	7.7	0.6	5.8
1830	24.3	32.2	25.9	31.7	13.0	25.1
1982	29.9	23.3	23.5	30.8	25.4	29.8
2135	24.4	18.9	24.7	26.0	33.1	26.3
2287	10.3	6.7	7.4	2.9	19.5	11.7
2440	0.9	2.2	1.2	-	7.7	1.2
2592	-	-	-	-	0.6	-

See Appendix 6 for locations of areas.

Appendix 11. Frequency distribution in percent, of aspect categories occurring on mountain goat use areas along the Rocky Mountain Front.

Aspect	RMF	North	Center	South	Conc. Areas Total	Conc. Areas North	Conc. Areas Center	HD415	HD414
North	11.1	14.4	11.4	6.3	12.5	15.6	9.9	16.8	11.1
NE	14.7	18.1	14.4	10.6	15.7	20.3	11.9	21.3	13.9
East	17.2	17.7	16.8	16.9	18.7	20.3	17.3	19.8	18.3
SE	12.0	8.7	14.4	13.7	12.1	9.2	14.4	9.1	13.0
South	8.8	10.5	7.4	8.1	6.7	7.2	6.3	8.6	6.1
SW	12.5	10.9	13.0	13.9	14.3	11.4	16.7	9.1	16.0
West	15.0	9.1	15.0	22.6	12.2	7.5	16.0	8.1	13.5
NW	8.4	9.6	7.5	7.9	7.5	7.8	7.2	6.1	7.9
Flat	0.4	1.0	0.1	-	0.4	0.6	0.2	1.0	0.2

	Concentration					
	Area A	Area B	Area C	Area D	Area E	Area F
North	15.0	18.9	14.2	9.6	8.3	11.7
NE	17.8	25.6	19.1	11.5	10.1	14.0
East	18.7	21.1	21.0	15.4	19.5	16.4
SE	9.3	8.9	9.3	17.3	14.8	12.3
South	14.0	2.2	5.6	2.9	8.9	5.8
SW	10.3	7.8	14.2	24.0	16.0	12.9
West	5.6	11.1	6.8	15.4	11.2	21.1
NW	8.4	3.3	9.9	3.8	10.7	5.8
Flat	0.9	1.1	-	-	0.6	-

See Appendix 6 for locations of areas.

Appendix 12. Frequency distribution in percent, of increments of slope occurring on mountain goat use areas along the Rocky Mountain Front.

Slope %	RMF	North	Center	South	Conc. Areas Total	Conc. Areas North	Conc. Areas Center	HD415	HD414
0-10	3.5	4.3	2.9	3.1	1.7	2.5	1.1	3.6	1.2
10-20	6.0	8.4	3.4	5.8	3.2	3.6	2.9	4.6	2.8
20-30	10.5	12.8	9.3	8.9	9.2	8.6	9.7	13.7	7.8
30-40	12.6	11.8	12.8	13.5	9.8	10.0	9.7	10.2	9.7
40-50	14.7	14.3	15.5	14.5	12.6	12.5	12.6	11.7	12.9
50-60	14.1	10.9	15.3	17.1	13.2	10.6	15.3	12.2	13.5
60-70	19.2	15.7	22.0	20.5	22.8	20.1	25.0	12.2	26.2
70-80	6.0	9.7	4.1	3.5	7.6	10.3	5.4	12.2	6.1
80-90	10.7	10.7	11.2	10.3	15.9	18.4	14.0	18.8	15.0
90-100	2.5	1.5	3.4	2.8	3.9	3.3	4.3	1.0	4.8

	Concentration					
	Area A	Area B	Area C	Area D	Area E	Area F
0-10	3.7	3.3	1.2	-	0.6	2.3
10-20	7.5	1.1	2.5	1.0	2.4	4.7
20-30	18.7	7.8	2.5	15.4	6.5	9.4
30-40	11.2	8.9	9.9	3.8	12.4	10.5
40-50	12.1	11.1	13.6	15.4	10.7	12.9
50-60	8.4	16.7	8.6	20.2	16.0	11.7
60-70	12.1	12.2	29.6	26.9	27.8	21.1
70-80	13.1	11.1	8.0	1.9	5.3	7.6
80-90	11.2	27.8	17.9	8.7	13.6	17.5
90-100	1.9	-	6.2	6.7	4.7	2.3

See Appendix 6 for locations of areas.

Appendix 13. Frequency distribution in percent, of site types occurring on mountain goat use areas along the Rocky Mountain Front.

Site	RMF	North	Center	South	Conc. Areas Total	Conc. Areas North	Conc. Areas Center	HD415	HD414
Timber	40.9	43.7	37.6	41.2	31.8	33.7	30.2	40.1	29.0
Open Timber	24.8	20.0	27.8	27.7	24.8	22.3	26.8	18.3	26.9
Shrubs	4.2	8.8	1.6	1.0	3.5	6.1	1.4	10.2	1.3
Open	30.0	27.5	33.0	29.9	40.0	37.9	41.7	31.5	42.7

	Concentration					
	Area A	Area B	Area C	Area D	Area E	Area F
Timber	37.4	43.3	25.9	16.3	40.8	28.1
Open Timber	16.8	20.0	27.2	38.5	21.3	25.1
Shrubs	11.2	8.9	1.2	1.9	0.6	1.8
Open	34.6	27.8	45.7	43.3	37.3	45.0

See Appendix 6 for locations of areas.

Appendix 14. Chi-square comparison of different areas along the Rocky Mountain Front, based on five environmental parameters.

MAJOR AREAS[1]	TOPO	ELEV	ASP	SLP	SITE	CONCENTRATION AREAS	TOPO	ELEV	ASP	SLP	SITE
N/C*** [2]	.0000 [3]	.0000	.0000	.0000	.0000	A/B	.0039	.3143	.0785	.0144	.6412
N/S***	.0000	.0000	.0000	.0000	.0000	A/C**	.0755	.4918	.4313	.0000	.0002
C/S*	.0358	.0001	.0000	.4478	.2769	A/D**	.0018	.1895	.0008	.0000	.0000
N/RMF***	.0000	.0000	.0000	.0000	.0000	A/E*	.0038	.0000	.1087	.0001	.0008
C/RMF**	.0000	.0062	.4219	.0077	.0004	A/F*	.0196	.5888	.0114	.1488	.0009
S/RMF**	.0040	.0000	.0000	.0898	.0002	B/C**	.0000	.9085	.1612	.0025	.0002
RMF/ALL**	.0000	.0000	.1827	.0000	.0000	B/D***	.0000	.1943	.0063	.0000	.0000
N.Conc/C.Conc***	.0000	.0000	.0000	.0431	.0011	B/E**	.0000	.0000	.0006	.0046	.0040
414/415**	.0000	.0801	.0018	.0000	.0000	B/F*	.0000	.0212	.0316	.1934	.0009
						C/D*	.0733	.1609	.0061	.0001	.1408
						C/E	.0401	.0000	.0895	.3262	.0377
						C/F*	.0917	.0286	.0161	.1073	.9344
						D/E	.0002	.0000	.1506	.0471	.0001
						D/F	.0783	.1150	.2326	.0023	.0547
						E/F	.0166	.0001	.1101	.3374	.0793
						A/ALL**	.0889	.7024	.0977	.0012	.0007
						B/ALL**	.0000	.1543	.0369	.0259	.0046
						C/ALL	.6140	.1031	.4352	.0883	.1673
						D/ALL*	.0090	.1422	.0627	.0038	.0020
						E/ALL	.0161	.0000	.3298	.5269	.0397
						F/ALL	.1562	.6673	.2454	.9732	.4179

[1] N = north, C = center, S = south; 1, 2, 3, 4, 5, 6 = N. Conc. = North / S. Conc. = South Concentration Areas
RMF = Rocky Mountain Front
ALL = All Concentration Areas
HD = Hunting District

[2] * = 3 of 5 variables significantly different
** = 4 of 5 variables significantly different
*** = 5 of 5 variables significantly different

[3] Over 0.05 are not significantly different

Appendix 15. Mountain goats captured and marked on the Rocky Mountain Front of the Rocky Mountains, 1979-1982.[1/]

DATE	LOCATION	SEX	AGE	FREQUENCY	COLOR/SYMBOL	EAR TAGS RIGHT	EAR TAGS LEFT	COMMENTS
8/26/78	Mt. Frazier	?	Kid			A6046	A6047	
8/30/78	Mt. Frazier	M	Kid			J668	J669	Red Richey ear tag with black O
9/7/78	Mt. Frazier	M	Kid			A1452	A1453	Red Richey ear tag with black X
6/27/79	Mt. Frazier	F	3 yrs.	151.052	White w/black	A7477	A7476	Tranquilized w/24 mg succinyl choline chloride. Transmitter nonfunctional 9/18/82
7/14/79	Mt. Frazier	M	3 yrs.	151.185	Dark blue	A7493	A7494	Transmitter nonfunctional 9/82 Recaptured 7/14/82 (150.567)
7/14/79	Mt. Frazier	M	2 yrs.	Neckband	Black w/yellow	A7490	A7489	Recaptured 6/17/82
7/14/79	Mt. Frazier	M	2 yrs.	Neckband	Black w/yellow	A7498	A7497	See 6/17/82
7/23/79	Mt. Frazier	M	8 yrs.	150.723	Green	A7496	A7495	Transmitter nonfunctional 11/81 Retrieved 5/30/83
8/27/79	Mt. Frazier	F	4 yrs.	151.082	White w/black stripes	A1455	A1454	Transmitter nonfunctional 7/83
8/27/79	Mt. Frazier	F	4 yrs.	151.172	Black	A7492	A7491	Transmitter nonfunctional 1/5/85
8/27/79	Mt. Frazier	M	Kid			A7500	A7499	Orange plastic streamer in left ear Recaptured 7/15/82, Kid of 151.082
7/24/80	Our Lake	F	3 yrs.	151.222	Red	A7480	A7489	Transmitter nonfunctional 5/83
7/24/80	Our Lake	M	1 yrs.	151.851	Black/White stripe	A6253	A6355	Dead goat located 8/13/82, collar and ear tag (A-6355) retrieved
7/24/80	Our Lake	M	Kid			A7488	A7478	Yellow tag in right ear
7/10/81	Mt. Frazier	F	1 yrs.	151.526	White elastic			Radio retrieved 7/9/82
7/20/81	Mt. Frazier	F	1 yrs.	151.430	Black elastic	A10573		Recaptured 6/23/82 (150.551)

Continued on next page.

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Appendix 15. Continued

DATE	LOCATION	SEX	AGE	FREQUENCY	COLOR/SYMBOL	EAR TAGS RIGHT	EAR TAGS LEFT	COMMENTS
7/20/81	Mt. Frazier	M	1 yrs.	151.013	Red elastic	A6264	A6265	Recaptured 6/22/82 (150.539)
7/27/81	Mt. Frazier	F	1 yrs.	150.912	Green elastic		A10554	Transmitter nonfunctional 11/81
7/27/81	Mt. Frazier	F	4 yrs.	151.814	Red / Yellow	A10553		Recaptured 6/23/82 and 7/15/82
7/27/81	Mt. Frazier	M	3 yrs.	151.788	Yellow/red		A10574	Transmitter nonfunctional 3/82
6/17/82	Mt. Frazier	M	Adult	151.863	Yellow/black	A9631	A9630	Right horn tip broken
6/17/82	Mt. Frazier	M	Adult	150.698	Blue/red	A9628		Right horn broken
6/17/82	Mt. Frazier	M	Adult	Neckband	Black/yellow	A7490	A7489	Captured 7/14/79
6/17/82	Mt. Frazier	M	Adult	150.340	Blue/yellow			Alive 1985
6/17/82	Mt. Frazier	M	6 yrs.	150.567	Lt. Blue/yellow stripe	A7498	A7494	Captured 7/14/79 (151.185-Blue PVC) Alive 1985
6/17/82	Mt. Frazier	M	3 yrs.	150.708	Green/red	A9627	A9629	Alive 1985
6/22/82	Mt. Frazier	F	2 yrs.	150.531	Black elastic	A9636	A9637	Transmitter nonfunctional 10/83
6/22/82	Mt. Frazier	M	2 yrs.	150.539	Yellow elastic	A8264	A8265	Captured 7/20/81, recaptured 7/15/82 (151.013-red elastic) Transmitter nonfunctional 9/83
6/22/82	Mt. Frazier	M	Adult	151.180	Green/yellow X	A9635	A9634	Alive 1985
6/22/82	Mt. Frazier	M	Adult	150.269	Black/blue		A9632	Alive 1985
6/23/82	Mt. Frazier	F	2 yrs.	150.551	Yellow/red stripe elastic	A10573		Captured 7/20/81 (151.430-black elastic)
6/23/82	Mt. Frazier	M	2 yrs.	Neckband	Orange/White 2	A10540	A10539	

Continued on next page.

Appendix 15. Continued

DATE	LOCATION	SEX	AGE	FREQUENCY	COLOR/SYMBOL	EAR TAGS RIGHT	EAR TAGS LEFT	COMMENTS
6/23/82	Mt. Frazier	F	5 yrs.	151.814	Yellow/red	A10553		Captured 7/27/81, recaptured 7/15/82 Kid was not captured
7/15/82	Mt. Frazier	M	2 yrs.	150.539	Yellow elastic	A8264	A8265	Captured 7/20/81, recaptured 6/22/82 transmitter nonfunctional(151.013)
7/15/82	Mt. Frazier	F	5 yrs.	151.814	Red Yellow	A10553		Captured 7/27/81, recaptured 6/23/82 Died 10/82 Retrieved 12/82
7/15/82	Mt. Frazier	F	2 yrs.	150.551	Yellow w/red stripe elastic	A10573		Captured 7/20/81, recaptured 6/23/82 transmitter nonfunctional 10/83 (151.430)
7/15/82	Mt. Frazier	M	Kid	150.590	Blue w/green streamers elastic	A9644	A9645	Transmitter nonfunctional 7/83
7/15/82	Mt. Frazier	F	3 yrs.	150.492	Green elastic	A9643	A9642	Killed by hunter 10/10/82
7/15/82	Mt. Frazier	F	Adult	151.230	Yellow	A9649	A9648	Alive 1986
7/15/82	Mt. Frazier	F	2 yrs.	151.240	Light blue	A10535		One horn broken. Alive 1986
7/15/82	Mt. Frazier	M	3 yrs.	Neckband	Green w/white	A9641	A9640	Killed by hunter 10/31/82
7/15/82	Mt. Frazier	M	3 yrs.	Neckband	Orange w/white	A7500	A7499	Red plastic streamer in left ear from 8/27/79. Alive 1986
7/15/82	Mt. Frazier	F	Adult	Neckband	Blue w/white	A10530	A10538	Had kid in 1985
7/15/82	Mt. Frazier	F	5 yrs.	Neckband	Red w/white	A10534	A10533	Alive 1986, no-kid 1984-86.
7/15/82	Mt. Frazier	F	Adult	151.290	Black w/yellow stripe	A10527	A10526	Died 2/84 Retrieved 5/9/84 Had kid in 1985, non-kid in 1986

1/ Goats captured in 1978 and 1979 were handled by Mike Thompson, in 1980 by Doug Tomasko and in 1981 and 1982 by Gayle Joslin.

Appendix 16. Body measurements of eleven mountain goats captured at the Blackleaf lick site during June and July, 1981 and 1982.

Ear Tag No.		Sex/Age	Neck	Body	Shoulder	Chest	Rostrum	Beard	Ear	Horn Measurements			
										Length		Circumference	
Right	Left	in yrs.	Girth	Length	Height	Girth	Length	Length	Length	Right	Left	Right	Left
No tag		F/1	30.5[1/]	88.9	63.5	71.1			10.2	10.2	10.2	7.6	7.6
	A10554	F/1	23.5	94.0	61.0	67.3	17.1[2/]		10.2	10.2	10.2	7.0	7.0
A10573		F/1	26.7	99.1	66.0		17.1[2/]		10.8	12.7	12.1	8.3	7.6
A10573		F/2	33.0		66.0		15.2[3/]	7.6		15.2	15.2	8.3	8.3
A9643	A9642	F/3			73.7		15.2[3/]			17.8	17.8	8.9	9.5
A9643	A9642									17.2[4/]	18.4	10.2	9.5
A10553		F/4	33.0	119.4	83.2	96.5	24.8[2/]		12.7	20.3	19.7	10.2	9.5
A10534	A10533	F/5	41.3		83.8		24.1[2/]						
A6264	A6265	M/1	31.7	101.6	68.6		17.8[2/]		10.8	14.0	12.7	8.9	7.6
A10540	A10539	M/2	43.2		76.2		15.2[3/]	10.2		17.8	17.8	10.2	10.2
A7500	A7499	M/3	34.3		90.2		17.8[2/]			21.6	21.0	12.1	12.1
A10530	A10538	M/3	39.4		92.7		20.3[2/]	10.2					
A9641	A9640	M/3								20.3[5/]	20.3	12.1	11.7
	A10574	M/3	35.6	96.5	71.1	87.6	19.4[2/]		10.8	20.3	20.3	10.5	10.5

1 All measurements in centimeters.
2 Rostrum measured from end of nose to base of horns.
3 Rostrum measured from end of nose to corner of eye.
4 Measurements from harvested animal killed October 10, 1982.
5 Measurements from harvested animal killed October 31, 1982.

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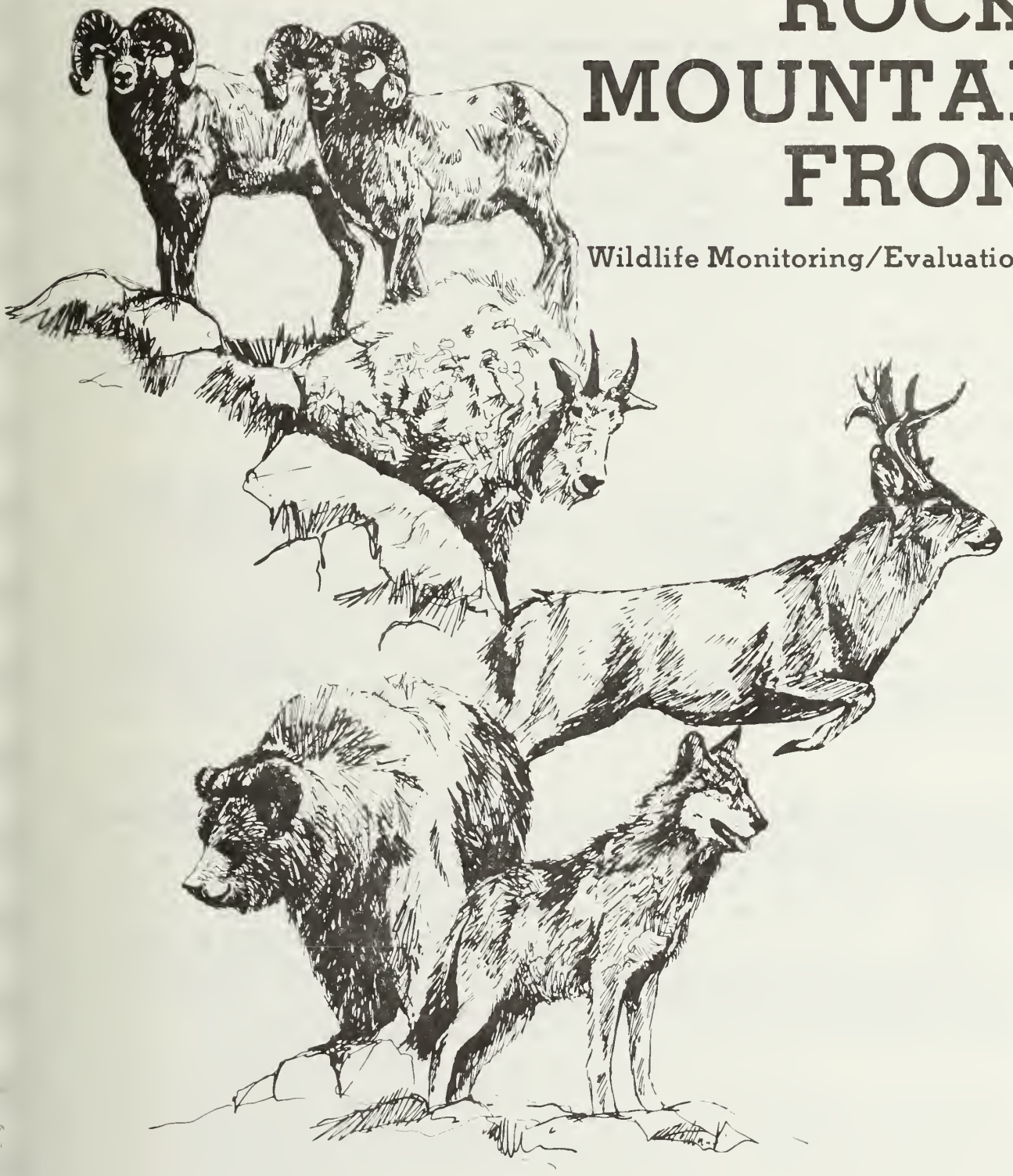
Interagency

ROCKY MOUNTAIN FRONT

Wildlife Monitoring/Evaluation Program



Management Guidelines for Selected Species, Rocky Mountain Front Studies

Interagency Rocky Mountain Front
Wildlife Monitoring/Evaluation Program

Management Guidelines

Grizzly Bear	Elk
Mountain Goat	Mule Deer
Bighorn Sheep	Raptors

Approved by:

Dale Gorman — 4/2/84
John D. Gorman, Forest Supervisor — Date
Lewis and Clark National Forest

Glenn W Freeman — 4/6/84
Glenn Freeman, District Manager, — Date
Bureau of Land Management, Lewistown District

Wayne H Brewster — 4-3-84
Wayne Brewster, Field Supervisor, — Date
U.S. Fish and Wildlife Service

Dan Vincent — 4/5/84
Daniel Vincent, Regional Supervisor, — Date
Montana Department Fish, Wildlife and Parks

Introduction

The Interagency Rocky Mountain Front Wildlife Monitoring/Evaluation Program was initiated in 1980. A principal goal of this program was to sponsor study efforts; whereby wildlife management guidelines, based on sound scientific findings, could be developed to aid land managers in their planning of human activities along the Rocky Mountain Front.

The original charter for this program specified that management guidelines were to be considered "interim" until five years of study had been incorporated into them. However, the guidelines developed thus far are currently being used as firm guidance by the involved agencies. Further, at the end of this five year period these guidelines should not be locked in concrete by the term "final". It is highly likely that studies will continue and additional findings will dictate new or revised guidelines. Therefore, these two terms will not be used and the management guideline development process and associated document are to be considered part of a dynamic planning process subject to periodic review and modification as additional study findings become available and as long as the need for them is present.

In the event that on-going monitoring results in the need for a new guideline or the modification of an existing guideline, it can be submitted at anytime by the procedures described and on the form given on the last two pages of this document.

The following management guidelines are based on the best information currently available. They are a result of current or recently completed studies on selected wildlife species. Field investigators conducting the studies have completed extensive literature reviews on the various species considered. The guidelines which have been formulated and presented in this document are not only the result of study findings and literature review, but incorporate the professional judgement of the technical personnel involved.

Objective

The need for management guidelines is predicated on management concerns involving the effects of existing and proposed land uses and human activities upon various wildlife species and their habitat. The objective of the development and application of management guidelines is to avoid or minimize the following effects of human related activities which may adversely impact some or all of the selected wildlife species being considered:

A. Physical destruction of important wildlife habitat components.
B. Human disturbance that would displace various wildlife species from important seasonal use areas.
C. Increased direct human caused mortality.
D. Increased stress due to higher human activity levels.
E. Direct mortality or physical impairment resulting from environmental (chemical) contaminates.
F. Increased wildlife/human interaction resulting from habitat intrusion or displacement.

Management Guidelines

Management guidelines provide coordination measures designed to avoid or minimize the potential conflicts previously identified between human related activities and wildlife. Although many of the guidelines are applicable to a variety of human activities, some of them are specific to a single activity. Oil and gas exploration and development has received special emphasis due to the relatively high level of activity in recent years. As a result, some of the guidelines apply specifically to that activity.

Approved management guidelines will be included in permits, contracts or other formal authorizations for human activities as applicable. Omissions or modifications of applicable guidelines in such authorizations will be documented in an EA report or other appropriate document concerning the activity involved.

Monitoring

A majority of the radio tracking and habitat survey data collected to date has been baseline information including the identification of seasonal ranges, reproduction areas, breeding areas and migration corridors. Future studies will place increasing emphasis on the monitoring of effects of increased human activity levels, particularly those associated with oil and gas exploration, on the wildlife species being studied. The management guidelines presented in this document are only partially based on monitoring information collected during the current studies on the Rocky Mountain Front. An important consideration in further monitoring efforts will be to test and validate the guidelines as to their effectiveness and applicability.

PART A. General Management Guidelines

The following general management guidelines are applicable coordination measures that will be considered when evaluating the effects of existing and proposed human activities in identified seasonally important habitats for a variety of wildlife species.

1. Identify and evaluate for each project proposal the cumulative effects of all activities, both existing uses and other planned projects. Potential site specific effects of the project being analyzed are a part of the cumulative effects evaluation which will apply to all lands within a designated biological unit. A biological unit is an area of land which is ecologically similar and includes all of the yearlong habitat requirements for a sub-population of one or more selected wildlife species.

2. Avoid human activities or combinations of activities on seasonally important wildlife habitats which may adversely impact the species or reduce the habitat effectiveness.

3. Space concurrently active seismographic lines at least nine (9) air miles apart to allow an undisturbed corridor into which wildlife can move when displaced. One line survey crew will be allowed to work between active lines in order to reduce the total time of activity in any one area.

4. Establish helicopter flight patterns of not more than one-half (1/2) mile in width along all seismographic lines, between landing zones and the lines, and between landing zones and other operations, unless flying conditions dictate deviations due to safety factors.

5. Because helicopters produce a more pronounced behavioral reaction by big game and raptors than do fixed-wing aircraft, helicopters will maintain a minimum altitude of 600 feet (183 meters) above ground level when flying between landing zones and work areas where landing zones are not located on seismic lines, unless species specific guidelines recommend otherwise (Hinman, H., 1974; McCourt, K.H., et al 1974; Klein, D.R., 1973; Miller, F.L. and A. Gunn, 1979).

6. Designate landing zones for helicopters in areas where helicopter traffic and associated human disturbances will have the minimum impact on wildlife populations. Adequate visual and/or topographic barriers should be located between landing zones and occupied seasonal use areas.

7. The use of helicopters instead of new road construction to accomplish energy exploration and development is encouraged.

8. Base road construction proposals on a completed transportation plan which considers important wildlife habitat components and seasonal use areas in relation to road location, construction period, road standards, seasons of heavy vehicle use, road management requirements, etc.

9. Use minimum road and site construction specifications based on projected transportation needs. Schedule construction times to avoid seasonal use periods for wildlife as designated in the species specific guidelines.

10. Locate roads, drill sites, landing zones, etc. to avoid important wildlife habitat components based on a site specific evaluation.

11. Insert "dog-legs" or visual barriers on pipelines and roads built through dense vegetative cover areas to prevent straight corridors exceeding one-forth (1/4) mile where vegetation has been removed (Stubbs, C.W. and B.J. Markham, 1979).

12. Roads which are not compatible with area management objectives and are no longer needed for the purpose for which they were built will be closed and reclaimed. Native plant species will be used whenever possible to provide proper watershed protection on disturbed areas. Wildlife forage and/or cover species will be utilized in rehabilitation projects where deemed appropriate.

13. Keep roads which are in use during oil and gas exploration and development activity closed to unauthorized use. Place locked gates and/or road guards at strategic locations to deter unauthorized use when activities are occurring on key seasonal ranges.

14. Impose seasonal closures and/or vehicle restrictions based on wildlife or other resource needs on roads which remain open.

15. Bus crews to and from drill sites to reduce activity levels on roads. Shift changes should be scheduled to avoid morning and evening wildlife feeding periods.

16. Keep noise levels at a minimum by muffling such things as engines, generators and energy production facilities.

17. Prohibit dogs during work periods.

18. Prohibit firearms during work periods or in vehicles traveling to and from work locations.

19. Seismographic and exploration companies should keep a daily log of activities. Items such as shift changes, shut down/start up times, major changes in noises or activity levels, and the location on the line where seismic crews are working should be recorded.

PART B: Species Specific Management Guidelines

The species specific management guidelines which follow provide coordination measures necessary to protect important habitats or seasonal use areas for several wildlife species which were selected for intensive baseline surveys on the Rocky Mountain Front Study Area. Monitoring of the effects of human activities on these species and their habitats will continue to receive special study emphasis.

Maps which delineate the seasonally important habitats for which timing restrictions are specified have not been included in the management guideline document and are not available for general distribution. Copies of these maps are available for inspection at the offices of the four Agencies involved in the Rocky Mountain Front Wildlife Monitoring Program.

These guidelines together with the "general management guidelines" will minimize, but not eliminate, the impacts of disturbances caused by human activities on these species. Species specific guidelines are currently available for grizzly bear, mountain goat, bighorn sheep, elk, mule deer and raptors.

Mountain Goat

The Montana Mountain Goat Investigations along the East Front of the Rocky Mountains, funded by the Montana Department of Fish, Wildife and Parks, the Lewis and Clark National Forest and the Allen Foundation, is the basis for formulating management guidelines (Thompson 1980; Tomasko 1980; Joslin 1984, 1983, 1982, 1981). Literature concerning wildlife (primarily mountain goats) and land use conflicts was also used in developing some of the guidelines.

The guidelines are heavily oriented toward disturbance related to oil and gas activity since that is the primary activity of concern now, however, other activities which may influence mountain goats are also addressed. The following guidelines are based on historic information from this area and data collected duirng the last four years. These guidelines represent the best information now available.

All previously mentioned "general management guidelines" are coordination measures that should be considered when evaluating human activities in mountain goat habitat. The following is adapted from the mountain goat investigations annual report (Joslin, 1984) and provides species specific guidelines which are applicable to a variety of human activities.

1. Avoid human activities in identified mountain goat habitat during the following seasonal use periods:

   A. Occupied yearlong mountain goat habitat
      1) Kidding - nursery areas ---------- May 1 - July 15
      2) Breeding areas ---------- November 1 - December 31
      3) Winter range ---------- October 15 - May 15

   B. Suitable low occupancy mountain goat habitat
      (Appropriate surveys of suitable mountain goat habitat will be made by a wildlife biologist to determine whether goats are present prior to initiation of a planned activity. If goat use is documented, the stratification will be changed to occupied yearlong mountain goat habitat and the listed guidelines will apply. If mountain goat use is not documented, then guidelines listed for transitional areas will apply).

   C. Transitional mountain goat habitat
      (The area between occupied yearlong habitat through which mountain goats travel. Timing restrictions apply to exploratory drilling, road construction and maintenance, timber harvest, off-road and trail vehicle travel, and any other mechanized activity which extends beyond one week in duration).

      ---------- October 15 - December 31
      and
      May 1 - June 30

2. Mineral licks used by mountain goats should have a no surface occupancy stipulation for a one-mile radius around the site (Joslin, 1984).

3. New mineral licks within mountain goat habitat should not be established without considering the safety of goats (Rideout, 1974).

4. Establish helicopter flight patterns at least one mile from mountain goat mineral licks during the May 1 - July 31 period (Joslin, 1984).

5. Restrict use of roads and trails which cross or come to within one-half mile of a mountain goat mineral lick to nonmotorized use during the May 1 - July 31 period.

6. Avoid constructing wells, pipelines or roads within 1 mile of occupied yearlong habitat.

7. Establish flight patterns in advance when activities require the use of helicopters. Flight patterns should be located to avoid seasonally important mountain goat habitat during the use periods designated above.

8. Exploratory well drilling should not occur within occupied habitat. Exploratory drilling on adjacent sites within Suitable and/or Transitional mountain goat habitat should be staggered to provide a disturbance-free area for displaced mountain goats.

9. Livestock use of mineral licks used by mountain goats should occur after July 1 or pasture use staggered so that adjacent licks are not used simultaneously by livestock.

10. In occupied yearlong habitat, livestock grazing should be restricted to the period July 1 - October 15.

11. The level of livestock use in occupied habitat should not be increased, and grazing of domestic sheep should not occur.

12. No suppression of insects and disease should occur in occupied habitat unless adjacent resource values are threatened.

13. Timber harvest and road construction within occupied mountain goat habitat should be closely coordinated with the Montana Department of Fish, Wildlife and Parks to address the needs of mountain goats.

Appendix 18. MOUNTAIN GOAT POPULATION CHANGES AND ENERGY EXPLORATION ALONG MONTANA'S ROCKY MOUNTAIN FRONT

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Abstract: A mountain goat (Oreamnos americanus) study was initiated in 1981 on 823 km² along the east slope of Montana's Rocky Mountains to quantify population parameters and monitor energy exploration activity. Population estimates over a 5 year period, based on a marked sample of male and female mountain goats, averaged approximately 188 or a density of about 1 goat per 4.1 km². The Teton-Dupuyer segment declined an average of 11% per year while the Birch-Badger segment declined an average of 14% per year. Kid:adult female (K:ADF) (3 years and older) ratios declined from 53:100 in 1982 to 16:100 in 1984. Population composition varied from 70 to 82% adults, about 4.5% 2 year-olds, 5 to 10% yearlings, and 7 to 16% kids. Beginning in 1983, productivity of marked females declined, but recruitment to yearling age had declined beginning in 1981. The decline in total numbers, and K:ADF ratios did not appear to be related to weather, logging, livestock grazing, or sport hunting. The effects of pneumonia on the mountain goat population were not documented, however 2 dead mountain goats discovered in and near the study area had suffered from severe respiratory complications, coincident with a major die-off in bighorn sheep in the same area. It is hypothesized that population parameter changes may have been precipitated either directly, or indirectly as a result of energy exploration activity. Beginning in 1981, energy exploration dramatically increased. From 1981 to 1985, about 579 km of seismic lines were shot within mountain goat habitat. This activity peaked during 1983 and 1984. Radio-telemetry information did not indicate abandonment of home range, however the peak in seismic activity did coincide with reduced kid production/survival, and productivity was significantly negatively correlated ($p < 0.01$) with seismic activity. If the low K:ADF ratios continue, this population cannot be maintained.

Native mountain goats of Montana's Rocky Mountain Front (RMF) occur along the theoretically petroleum-rich Overthrust Belt. Research on mountain goats along the RMF from 1981 through 1985 has indicated a population decline. The purpose of this paper is to describe the mountain goat population along the RMF, document changes in population parameters, describe, the upsurge of human activity within the area, and the possible consequences of human-induced stress upon the population.

While some impact may be inevitable as human activity increases within mountain goat habitat, the magnitude and pace of the impact can be tempered by proper management, and implementation

of specific land-use guidelines (Interagency Rocky Mountain Front Wildlife Guidelines 1984, Joslin 1986) to reduce negative effects on these herds.

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STUDY AREA

The RMF study area (Fig. 1) occurs in the Sawtooth Mountains of northcentral Montana. Lying along the east slope of the Continental Divide, the study area extends some 82 km south of Glacier National Park to the main Sun River and is bordered on the east by the prairie. Geological forces shaped the magnificent reefs of the Rocky Mountain Front. The awesome cliffs and ridges of the RMF are composed primarily of Madison limestone from the Cambrian era, although the bulwark of the mountains is Precambrian sedimentary rocks (Alt 1985).

The most distinctive climatic feature of the area is the wind. During winter warm chinooks often over 160 km per hour, blows away and melts the snow on the eastern slopes and exposes forage. The coldest average winter temperatures (January) range from -8.9°C at East Glacier to -6.0°C at the Sun River's Gibson Dam. The warmest average summer temperatures (August) range from 15.9°C to 16.7°C, respectively. Yearly precipitation averages 59.7 cm at East Glacier and 47.0 cm at Gibson Dam (Nat. Oceanic and Atmos. Admin. 1980-1985). Maximum snow pack occurs in April with depths (from north to south) averaging 252.5 cm at Badger Pass (2103 m), 168.1 cm at Mount Lockhart (1951 m), and 148.3 cm at Wrong Ridge (2073 m) (U.S.D.A. SCS Snow Survey Records 1922-1985). Meteorological data indicate a subtle gradient toward warm and dry moving from north to south along the Front. Detailed descriptions of vegetation, habitat types and landtypes are described in Harvey (1980), Thompson (1980), Holdorf et al. (1980) and Holdorf (1981).

Mountain goat distribution along the RMF extends from near Glacier National Park 82 km south to the Sun River. A gap of 11 to 19 km exists between the northern extent of the Badger Creek herd and mountain goat habitat within Glacier National Park. Population density of mountain goats within the study area

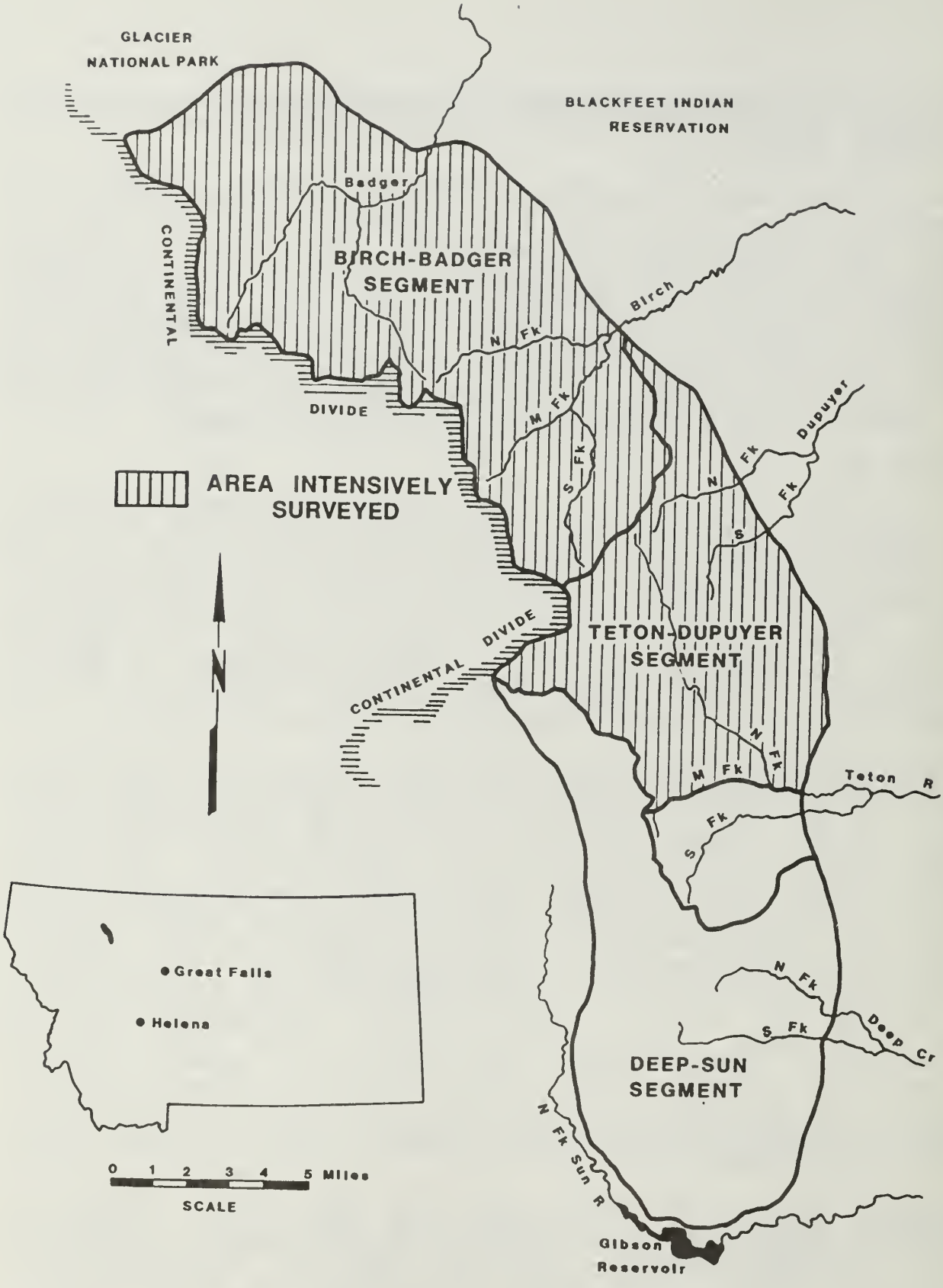

Figure 1. Rocky Mountain Front Study Area.

increases northward, although hunting and transplant records indicate that the Sun River-Deep Creek segment at one time had a significantly larger population.

METHODS

Repeated, systematic helicopter surveys were conducted on that portion of the population north of the Middle Fork Teton River (823 km², Fig. 1). Surveys were flown during July, from 1981 through 1985, during morning and evening hours, by the same pilot and observer, in a G3 47 Bell helicopter.

Thirty-five mountain goats in the Teton-Dupuyer segment were fitted with 23 radio collars, 8 neckbands, and 4 eartags (Thompson 1980, Joslin 1986). Nine and 6 adult males, 8 and 2 adult females, and 6 (4 females and 2 males) and 0 subadults were marked with radio-collars and neckbands, respectively. Four male kids were eartagged. All radio-collars placed on subadults were expandable elastic collars which were not observable from the air. During aerial telemetry, observations of radio-marked animals were obtained when possible. Both air and ground observations provided data on the reproductive histories of 9 radio-marked and 2 neckbanded females. Mountain goats were classified as adults (male or female), 2-year-olds, yearlings, and kids based on morphological features, molting patterns, and group assiciation.

Based on radio-marked and neckbanded animals known to be in the Teton-Dupuyer segment, each year an observability rate was calculated for adult males, and another rate was calculated for adult females (Table 1). The observability rate of marked adult females was applied to subadults since this age class was consistently seen with adult females. Five years of observability rates for adult males were combined to produce an average observability rate of 35%. The same process was used to calculate an average observability rate for adult females, of 82%. Actual July survey figures were adjusted using these observability rates to calculate an annual adjusted population level for the Teton-Dupuyer segment. The observability rates were extrapolated to the Birch-Badger segment. A population model was developed using POSIM (Mooney and Lonner 1978).

Table 1. Observability of marked mountain goats, July 1981 - 1985.

Year	Marked Females	No. Observed	% Observed	Marked Males	No. Observed	% Observed
1981	3	2	67	3	0	0
1982	7	6	86	11	4	36
1983	7	5	71	8	1	12
1984	7	7	100	10	5	50.0
1985	4	3	75	8	4	50.0
Total	28	23	82	40	14	35

Snow depth information was collected from the 3 snow survey sites which occur in the Birch-Badger, Teton-Dupuyer, and Deep-Sun segments of the study area, respectively. These sites occur either within mountain goat winter range, or in the case of Badger Pass, which is at the edge of the study area, at an elevation which coincides with mountain goat winter range.

Quantification of energy exploration activities was provided by Robin Strathy, geologist, and Lewis Young, biologist, Rocky Mountain Ranger District, Lewis and Clark National Forest.

The study area was divided into 3 segments: the northern Birch-Badger segment, the center Teton-Dupuyer segment, and the southern Deep-Sun segment (Fig. 1). This paper focuses on the Birch-Badger and Teton-Dupuyer segments.

RESULTS

Population Monitoring

Mountain goats in both the Teton-Dupuyer and the Birch-Badger segments declined over the course of the study. Newborn kids and the Kid:100AD Female ratio also declined (Tables 2 and 3). The adjusted population in the Teton-Dupuyer segment declined an average of 11% per year for a 43% decline from 1981 to 1985. The Birch-Badger segment declined an average of 14% per year for a 29% decline from 1982 to 1984. K:100ADF ratios in the Teton-Dupuyer segment declined from 38 in 1981 to 15 in 1983, and rose to 23 by 1985 (Table 2). Ratios in the Birch-Badger segment declined from 65 in 1982 to 13 in 1984.

Reproductive histories of from 1 to 6 years were documented for 11 marked adult female mountain goats. (Table 4). Potentially thirty-eight young could have been born to these females over the course of the study, assuming 1 kid born per female per year. Six of 18 kids that were born died, while the fates of 4 others were undetermined. No twins were produced. Sixty percent of the kids that died did so between July and September. Production ranged from a maximum of 100% (N=3) in 1979 to 0 (N=5) in 1984. Recruitment was highest prior to initiation of this study (Thompson 1980) and dropped to 0 by 1983-84.

The longevity of this population was estimated based on the 1984 population of 180, an equal sex ratio, average 1982-1984 birth rate of .37, and natural mortality rates of 4.3% adults, 5.5% 2-year-olds, 39.9% yearlings, 57.2% kids, hunter kills of 4 to 5 per year (3 to 4 adults and 1 yearling), and a 30% wounding loss (adult). Within 25 years, it is predicted that this population will have declined by about 74% to 47, and recruitment of yearlings and 2-year-olds will have declined to 0. Even with hunting mortality removed from the analysis, the population will continue to decline.

Table 2. Summer helicopter surveys of mountain goats in the Teton-Dupuyer segment, 1981-1985.

Adjusted Survey

YEAR	TOTAL	AD M/F	SA	KID	K:100ADF
1981	113	37/40	21	15	37.5
1982	99	46/30	12	11	36.6
1983	74	37/27	6	4	14.8
1984	95	43/34	11	7	20.6
1985	65	34/22	4	5	22.7

Actual Survey

1981	75	13/33	17	12	36.3
1982	60	16/25	10	9	36.0
1983	43	13/22	5	3	13.6
1984	58	15/28	9	6	21.4
1985	37	12/18	3	4	22.0

Table 3. Summer helicopter surveys of mountain goats in the Birch-Badger segment, 1982-1984.

Adjusted Survey

YEAR	TOTAL	AD M/F	SA	KID	K:100ADF
1982	119	43/40	10	26	65.0
1983	112	26/42	20	24	57.0
1984	85	29/40	11	5	12.5

Actual Survey

1982	77	15/33	8	21	63.6
1983	80	9/35	16	20	57.1
1984	56	10/33	9	4	12.1

Table 4. Reproductive history of 11 marked female mountain goats.

Radio #	Age Marked Yrs.	1979	1980	1981	1982	1983	1984	1985
1172	4	K	^{Y}K	^{Y}K-died	K-died	0	0	Trans[1]
1082	4	K	^{Y}?	?	?	0Trans		
1052	3	K-died	K	^{Y}K-died	K Trans			
1222	3		K	^{Y}K	^{Y}K	^{Y}Trans		
1290	AD				K-died	K	Dead[2]	
1230	AD				K	^{Y}0	0	0
42[3]	5				0	0	0	0
32[3]	AD				0	0	0	K
1240	2				---	0	0	0
1814	4				K-died	K dead[2]		
492	3					0		

[1] Trans = transmitter failed

[2] Dead = female goat died

[3] Neckband

Weather

Several authors have documented an inverse correlation between winter snow depths and kid survival (Chadwick 1973, Rideout 1974, Smith 1976, Bailey and Johnson 1977, Thompson 1980, Johnson 1983, Swenson 1985). The average of March, April and May snow depths from 3 snow survey sites in or near mountain goat winter range along the RMF from 1980 through 1985 indicated that winter snow pack has been at or below normal during 5 of 6 years. A regression of Teton-Dupuyer K:NK ratios upon snow depth showed little correlation ($r=0.5$, $df=5$, p 0.1). The relatively low snow depths apparently did not have an influence on kid survival.

Cool wet summers are also known to affect survival of newborn young (Brandborg 1955, Johnson 1983). Temperature and precipitation data during June, July and August from 1980 to 1985 indicated that summers have generally been slightly warmer and dryer than average. The month of June in particular, is critical, but 1981 was the only year slightly cooler than normal (-0.4 C), and 1983 and 1984 were the only years slightly wetter than normal (1.0 cm and 0.1 cm above the average, respectively). A combination of abnormally cold and wet conditions did not occur during the course of the study.

Hunter Harvest

Numbers of hunting permits issued for the 2 districts along the RMF have varied from 15 to 5 between 1974 and 1985, and currently stand at 8. An average of 4 to 5 mountain goats have been harvested per year. Since the beginning of this study in 1981, when population estimates were first determined, mountain goat harvest has not exceeded 4% of the population, and has averaged 3%. Females have composed 46% of the harvest, or between 2 and 3 per year. Mountain goat harvest on the RMF is managed more conservatively than areas of Colorado (7%), Alberta (5%), Idaho (4%), Alaska (10%), and British Columbia (7%) (Adams and Bailey 1982, Hebert and Turnbull 1977). Hunting, therefore, does not appear to be responsible for the observed population decline.

Livestock Grazing

Livestock grazing peaked along the Front in the early 1900's. Changes in allotment size, duration of use, species use, and management systems have helped reduce livestock competition with wildlife. Generally, livestock use is now at its lowest level in 50 to 80 years, and the current level of use has been maintained since the most sweeping changes were instituted in allotment use 10 to 20 years ago. Although livestock grazing continues to be a significant land use activity along the Front, the extent and degree of use has not appreciably changed in the last 2 decades, and would appear not to have created a new or increased stress upon the mountain goat population.

Timber Harvest

Approximately 1 million board feet (7,600 cubic meters) per year of timber has been removed from the Rocky Mountain Front over the past decade (USDA Lewis and Clark National Forest Plan 1986). Most of the few logging roads that created access into mountain goat range along the Front have been closed, and sales have generally not been located in critical mountain goat range. A significant conflict between the timber program and mountain goat habitat did not appear to exist.

Energy Exploration

Seismic exploration activity along the RMF has increased 37 fold from the 1960-1980 period when an average of 9.5 km of line was shot per year, to 1981-1984 when an average of 351.0 km of line was shot per year (Lewis and Clark NF, unpubl.). Wildcat drilling in the 59 years between 1921 and 1980 amounted to an average of 1 well drilled every 2.7 years. From 1981-1984 an average of 1 well per year was drilled. Although only a portion of this seismic and drilling activity occurred within the study area, the trend is clear. Nearly all of the 579 km of seismic lines which were shot in the mountain goat study area since 1981 were helicopter supported. An estimated 21.7 man days and 6 to 8 helicopter km are associated with each km of helicopter based seismic line shot within mountainous terrain along the RMF. This equates with 12,564 man days and about 4053 km of helicopter activity within the study area since 1981.

Mountain goat productivity was inversely correlated with seismic activity during the course of the study. Although the correlation between productivity and siesmic activity that year, or the previous year were weak ($R=-0.557$ and -0.369, P 0.05), correlations combining the seismic activity of adjacent years were significant: birth year plus previous year $R=-0.823$, P 0.05, 2 years prior to birth year $R = -0.742$, P 0.05, and birth year plus 2 previous years $R=-0.936$, P 0.01. Thus, the amount of seismic activity during 3 years explained 87% (R^2) of the variation in mountain goat natality during the third year.

Disease

In most respects, the observed pattern of mountain goat decline along the RMF parallels the pneumonia die-off in bighorn sheep (Onderka and Wishart 1984) which was coincidentally occurring along the RMF (Hook 1986). In the Teton-Dupuyer segment, it appears that the mountain goat decline was already in progress in 1982, although poor K:ADF ratios were not detected until 1983. For bighorns, Onderka and Wishart (1984) indicate that some adults initially succumb, while others may survive to become carriers and thus bear a poor lamb crop.

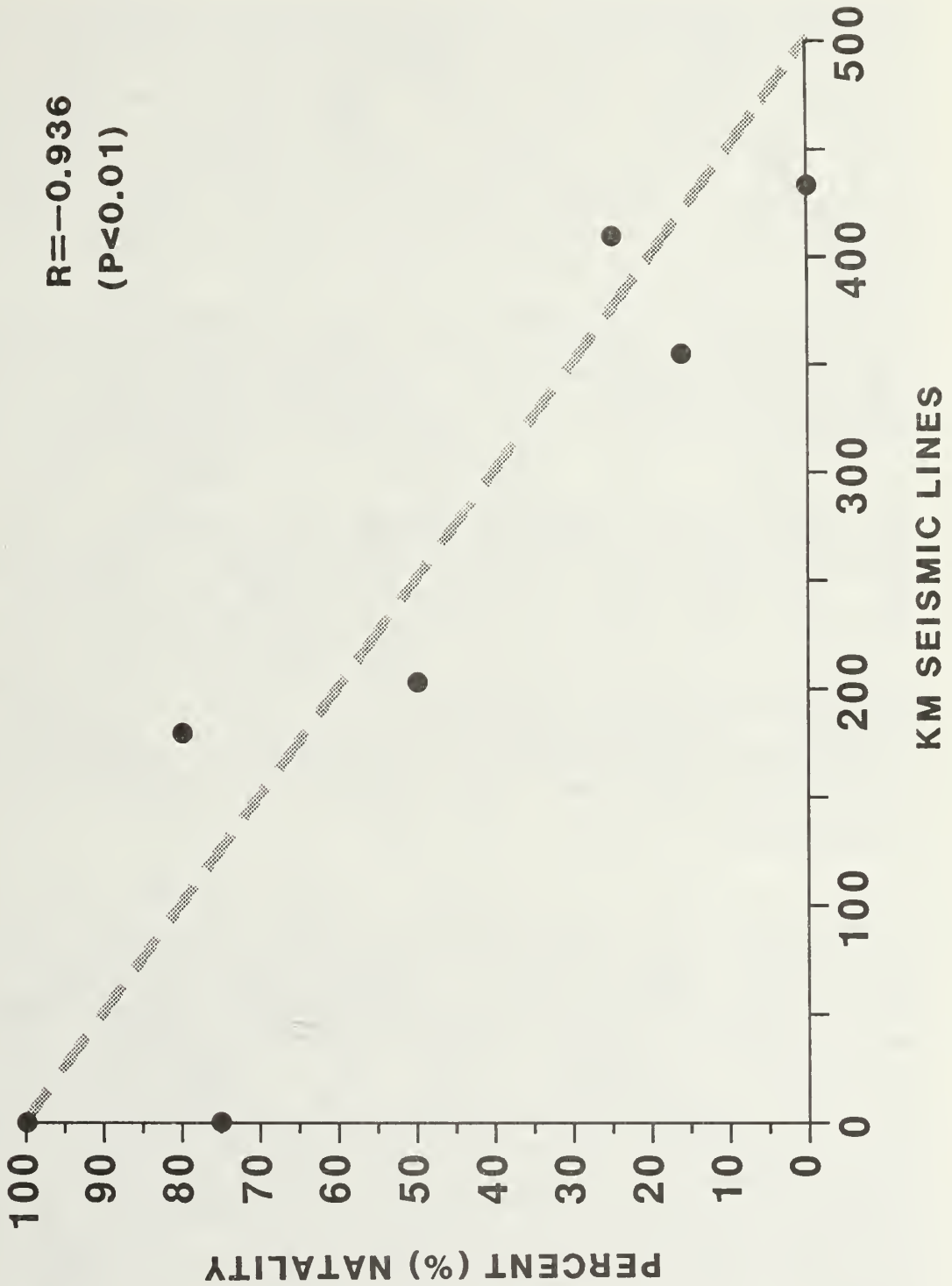

Figure 2. Productivity vs. cumulative seismic activity (birth + 2 previous years).

Although there was only slight to moderate distributional overlap between mountain goats and bighorn sheep in the study area, it is possible that an unknown epizootic could have been transmitted between these species, or have been contracted from some other ungulate which ultimately precipitated a disease-related population decline. Only limited information concerning the pathology of mountain goats is available to assess this possibility; however, Samuel et al. (1977) cite sources indicating that exchanges between species of most parasites are limited.

Limited evidence indicates that broncho-pneumonia might have been a contributing factor in the observed population changes. In 1983, 2 mountain goats were found dead along the RMF, one along the South Fork Teton River in Green Gulch (T. Bivins, 1983, pers. commun.) and the other near Many Glacier in Glacier National Park (K. Keating, 1985, pers. commun.). The Teton goat, a 5-6 year old male, was diagnosed as having fibrinopurulent bronchopneumonia (Corynebacterium sp.) (J. Rhyan, DVM, Lab Rpt. No. 8-470 Veterinary Lab, Bozeman, MT). The Glacier goat also suffered from severe suppurative pneumonia (M. Harries DVM, Path. No. L83-3228-H Alberta Animal Health Division, via Glacier National Park, MT). Dr. Harries noted that the pathological changes in the Glacier goat were essentially similar to those of the bighorn sheep which had been suffering from a Pasteurella hemolytica biotype T pneumonia in areas of Alberta, British Columbia, and the Rocky Mountain Front of Montana. Although significant bacteria could not be isolated, similar organisms to those of the sheep had very likely been present (op. cit.).

DISCUSSION

Except for human disturbance through seismic activity, other stress-inducing factors appeared to be minor over the course of this study. The correlation between productivity and seismic activity in previous years, suggest that the stress induced by this seismic activity is cumulative over perhaps 3 years. The 4 year period of very intensive activity probably created more stress than it would have, had the individual years of activity not been consecutive. Stemp (1983) indicated that pre-natal stress is of particular concern because the extreme sensitivity of the young is related to their rapid development, and the most rapid development of a mammal takes place as a fetus. "Precocial species, including [domestic goats and] sheep, are very sensitive (Moore 1958, 1968, Scott 1962). Particular organs and behaviours are especially susceptible during the critical periods in which they are maturing most rapidly (Scott 1962, Schaefer 1968). Indeed, consequent changes in development can be so pronounced that the individual's emotionality and behavior (Moore 1958, 1968, Joffe et al. 1973), phenotype (Schaeffer 1968) and even viability (Moore 1958, 1968) can be profoundly and permanently altered" (Stemp 1983).

A number of researchers have reported upon behavioral and physiological response of wildlife to helicopter harassment. Helicopters, sonic booms, gunshots, people on foot, stopped occupied vehicles, and domestic dogs elicit strong behavioral and/or heart rate responses from a variety of wildlife (Horejsi 1976, Ward and Cupal 1979, Gunn et al. 1983, Stemp 1983, Irwin and Gillin 1984). MacArthur et al. (1982), Stemp (1983), Ward and Cupal (1983) and others have indicated that behavioral response does not necessarily reflect physiological response to harassment. Despite the animals outward behavior, Stemp (1983) reported that heart rate of bighorn sheep was significantly elevated and remained elevated as long as helicopter activity occurred in their vicinity. Up to 45 minutes was required after the disturbance was gone for heart rate to return to normal. He indicated that "behavioral response can be extremely misleading: helicopters can sensitize bighorns and can produce marked and prolonged physiological responses in the absence of pronounced--or even any--behavioral reaction".

To avoid stress-inducing disturbance, an animal may withdraw, but withdrawal is also costly because exertion demands increased energy expenditure. Also injury is a risk during escape attempts, and the opportunity to feed at that location is removed. If animals withdraw from key habitat areas, carrying capacity can be reduced (Stemp 1983).

Abundant literature exists detailing the maladaptations that may result from repeated or prolonged stress stimulation, including decreased resistance to infection and disease (Jensen and Rasmussen 1970, Hudson 1972, Stein et al. 1976 - in Stemp 1983), and impaired or complete failure of reproductive function (Arshavsky 1968, Geber 1962, 1970; Petropoulos et al. 1972, Sontag 1970 - in Stemp 1983).

It is not known whether stress-induced pneumonia is the causative factor in the Rocky Mountain Front mountain goat population decline (although 2 necropsied mountain goats suggest that it may be), but the fact that the population is laboring under some form of stress is reflected in the current downward trend. While energy exploration may or may not be the only disturbing stressor, it appears to be the largest single one. In comparison, mountain goat populations in adjacent Glacier National Park (where no seismic activity has occurred) appears to be stable (K. Keating, 1985, pers. commun.). Stemp (1983) indicated that "any stressor sensitizes the individual to other stressors. Moreover, a prolonged stress response decreases an individuals ability to cope psychologically (Shanan et al. 1976) which is likely to make them more susceptible to subsequent stressors".

Detailed multi-agency guidelines were designed to ameliorate the effects of energy exploration activities upon wildlife along the Rocky Mountain Front. One objective of the guidelines was "to avoid or minimize human related activities which may adversely impact selected species of wildlife". The mountain goat population decline suggests that the guidelines were insufficient to maintain the pre-development population level of mountain goats in the face of intense human activity. The guidelines were particularly deficient in controlling distribution of seismic activity. If the mountain goat population is to increase and be maintained at or above the 1980 level, managing the timing and intensity of human activity within mountain goat habitat will be critical.

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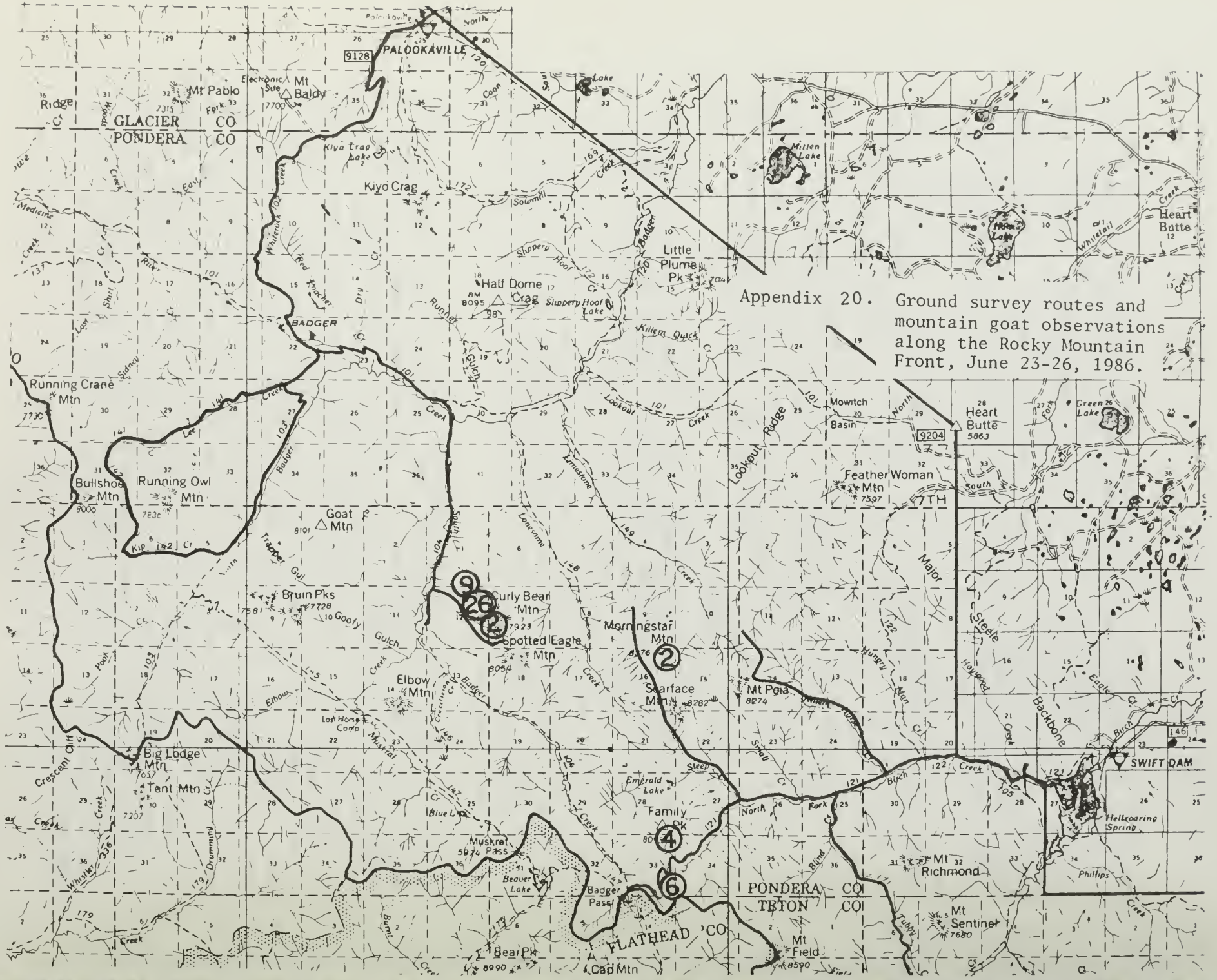
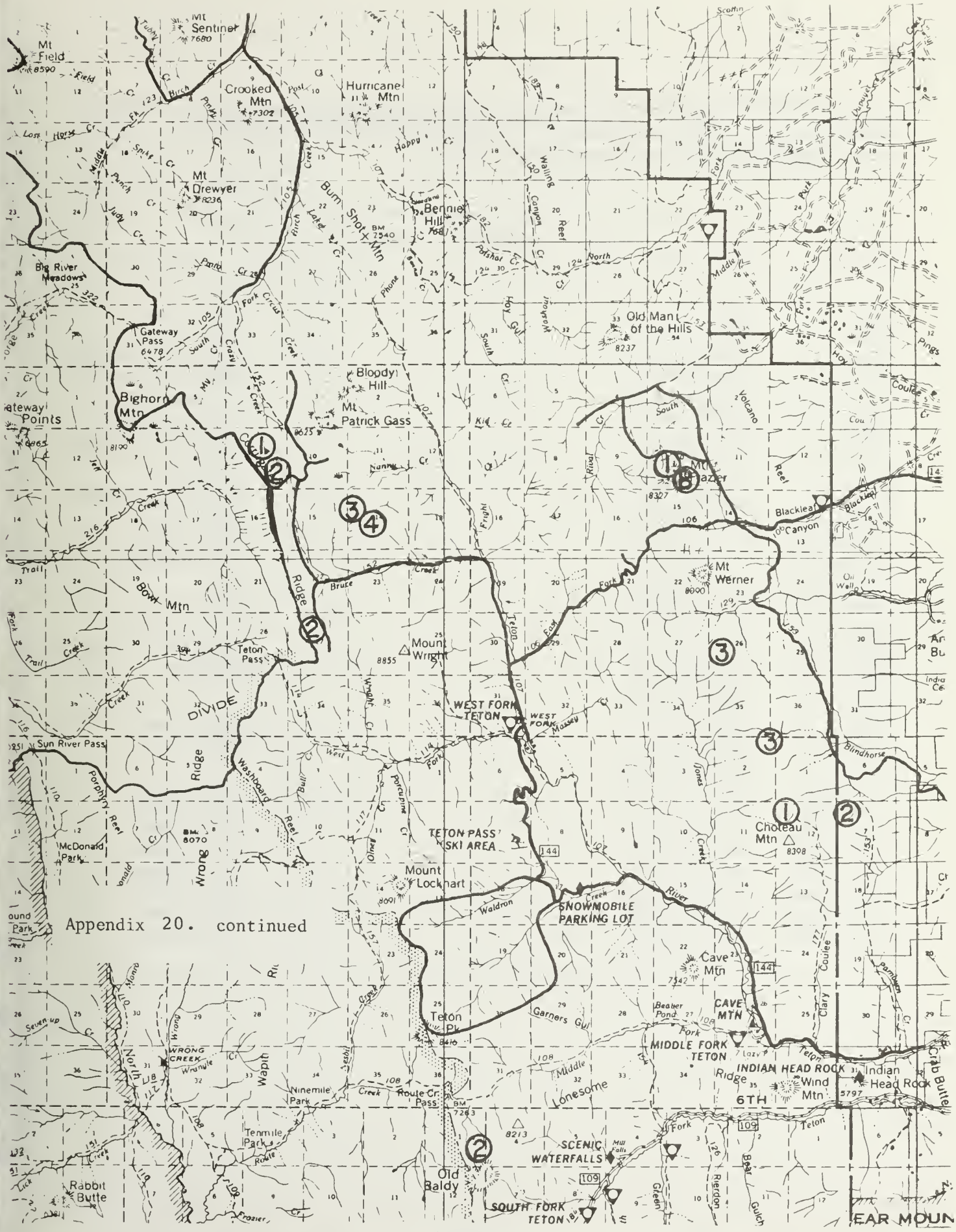
Appendix 19. Mountain goat ground survey conducted from Middle Fork Teton to Badger Creek, June 23-26, 1986.

Twelve individuals participated in a systematic mountain goat ground survey conducted June 23-26, 1986. On foot, Rich DeSimone, Stacy Kiser (volunteer) and Gayle Joslin covered Bruce, Crazy, Circus creeks, portions of Trail Creek (from Corrugate Ridge), and North Fork Teton, East Fork Teton, Blackleaf, South Fork Dupuyer, and Rival Creek. Nine person-days were spent covering this area. On horseback, John McCarthy, Dan Hook, Dick Buscis, and Bob Watts covered the North, Middle, and South Forks of Birch Creek. Twelve man-days were involved. Stuart Buchanan (volunteer - FS biologist) spent one day on foot in the Middle Fork Teton area. Gary Olson and Greg Kushnac (volunteer) spend a total of 7 man-days on motorcycles and foot covering North and South Badger Creeks including Lee, Kip, and Lonesome Creeks. Barbara Buls and Rich Kirchner (volunteers) spent 5 person-days on foot covering the ridge between North Fork Birch and Badger Creeks including Killem Horse, Small, Steep, Lonesome, and Limestone creeks. Mountain goat observations and survey routes are illustrated in Appendix 20.

Areas not systematically covered from the ground included Jones, Massey, Fright, Kid, North Fork Dupuyer (Walling Reef) creeks. Particularly Jones Creek and North Fork Dupuyer should be covered during future surveys. Early morning (until 08:00) and evening (after 19:00) were the most effective times of day to observe. Survey routes, camp sites, and observation points should be adjusted to ensure that these scoping periods can be accommodated in the future. Mountain goats were probably missed in Rival and Birch creeks because they were surveyed too late in the morning or in the afternoon.

A total of 82 unduplicated sightings (23M, 27F, 7AD, 1-2Y, 6Y, 1SA, 15K, 1UN) were recorded, the specifics and locations of which are listed in Appendix 21. Six marked goats, including 1 neckbanded, 1 ear-tagged, and 2 radio-collared females; and 2 radio-collared and 1 ear-tagged male were observed. The ear-tagged male was observed at the Curly Bear lick, some 32 air km northwest of the Blackleaf lick where it was originally marked. About 10% of the goats could not be classified to age or sex. (Less than 1% could not be classified from the air.) Specific classification data is essential to determine trends in population dynamics; at least 90% of all goats observed from the ground should be classified. Experienced observers should be utilized, and adequate reference material should be distributed to observers to ensure accurate classifications. A simple count of goat numbers can mask variability in production and recruitment rates which are important indicators as to the health of the population. Survey efficiency from the ground was 70% that of the June 17-18 air survey (82 ground compared to 117 air observations).


PALOOKAVILLE
9128
GLACIER CO
PONDERA CO
Mt Pablo
Mt Baldy
Kiyo Crag
Kiyo Trap Lake
Little Plume Pk
Half Dome Crag
BADGER
Running Crane Mtn
Bullshoe Mtn
Running Owl Mtn
Goat Mtn
Bruin Pks
Curly Bear Mtn
Spotted Eagle Mtn
Morningstar Mtn
Scarface Mtn
Elbow Mtn
Big Lodge Mtn
Tent Mtn
Muskrat Pass
Family Pk
Badger Pass
Bear Pk
Cad Mtn
FLATHEAD CO
PONDERA CO
TETON CO
Mt Field
Mt Sentinel
Mt Richmond
Mt Pond
Feather Woman Mtn
Heart Butte
9204
Mowitch Basin
Lookout Ridge
Green Lake
Hellroaring Spring
SWIFT DAM
146
Emerald Lake
Blue Lk
Beaver Lake
Phillips
Backbone
Crescent Cliff
Whistler
Drummond
Lost Horse Camp
Trapper Gul
Gooly Gulch
Limestone
Lonesome
Slippery Hoof Lake
Killem Quick Gulch
Sunny Lake
Mitten Lake
Whitetail
Heart Butte
Ridge
Creek
Lake
Pool
Basin
Gulch
Pass
Cliff
Fork
Cr
Mtn
Pks
Lk
Pk
Site
Comp
Trail
Road
Hwy
Line
Bend
Flats
Spring
Meadow
Valley
Canyon
Ridge
Basin
Butte
Lake
Creek
Fork
Cliff
Gulch
Pool



Appendix 20. continued

Appendix 21. Location and classification of mountain goats observed during ground survey of the area east of the Continental Divide and north of Middle Fork Teton to Badger Creek, June 23-26, 1986.

Drainage	UTM Location	Total	Adult			Subadult			Kid	Un	Comments
			M	F	Un	1	2	Un			
Bruce Cr	236210/531870	4	1	2					1		Bruce Mtn
Bruce Cr	236120/531860	3		1			1		1		Bruce Mtn
Bruce Cr	235870/531990	2	2								Corrugate Ridge
Bruce Cr	235940/531650	2	2								Corrugate Ridge
Nanny Cr	236210/531920	2	1	1							(duplicate)
Crazy Cr	235820/532070	1	1								Corrugate 6982
Crazy Cr	235840/532020	2	2								Corrugate (dup)
Blackleaf	236970/531960	8	3	4		1					Frazier, 2402
Muddy Cr	237120/531410	3		1	1				1		Annie Pk
S FK Dupuy	236930/531980	1		1							Frazier, 2302-?
Limestone	235130/533870	2		1					1		Morningstar
Lonesome Cr	234790/533715	2	1	1							Morningstar
Blindhorse	237160/531260	3		1			1		1		M. Washington
Frenchy Cr	237340/531050	2		1					1		
Frenchy Cr	237230/531040	1		1							Choteau Mtn
Jones Cr	237170/531190	1								1	M. Washington
Blackleaf	236960/531920	1	1								Frazier
Blackleaf	236970/531940	2		1		1					Frazier
Crazy Cr	235830/532080	3			3						Corrugate (dup)
N FK Birch	234990/533280	2		1					1		
N FK Birch	234990/533390	4		1	2			1			Family PK
N FK Birch	235120/533280	2			2						Badger Pass
N FK Birch	235050/533260	2		1					1		
S FK Badger	234510/534080	9	1	4			1		3		Curly Bear
S FK Badger	235150/534110	19	9	4			2		4		Curly Bear
S FK Badger	235150/534120	3	3								Curly Bear
S FK Badger	234870/533940	2			2						Curly Bear
S FK Badger	234490/534100	4		2			2				Curly Bear-dup.
S FK Badger	234550/534060	2	2								Curly Bear
S FK Badger	234500/534090	2		1			1				Curly Bear
S FK Badger	234510/534120	20	5	7			3		5		Curly Bear

Appendix 22. Incomplete helicopter surveys of mountain goats along the Rocky Mountain Front, 1979-1984.

Survey Date	Area Covered	Total	M	F	AD	2	Y	SA	K	Un
7/79	Birch - spot	3								3
11/79	Birch - spot									
3/80	Birch - spot	2								2
8/80	Birch - entire	16							5	11NK
3/81	Birch - Badger entire	71			44			7	15	5
7/81	Birch - entire	44	-	-	21	-	-	11	9	3
4/82	Birch - spot	14	2	-	5	-	3	-	3	1
12/84	Birch - entire	30	6	5	14		3		2	
3/79	NF Dupuyer to SF Teton - entire	49								49
7/79	NF Dupuyer to SF Teton - entire	66			6				15	45
3/80	NF Dupuyer to SF Teton - entire	53			9			2	8	34
8/80	NF Dupuyer to SF Teton - entire	74							22	51
3/81	NF Dupuyer to SF Teton - entire	88			49			4	20	15
4/82	NF Dupuyer to SF Teton - spot	23	2	2	7		2	2	6	2
4/84	NF Dupuyer to SF Teton - entire	60	14	29	2	2	7		6	

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Appendix 23. Location and classification of mountain goats observed during helicopter survey of Rocky Mountain Front, March 11 and 12, 1981.

Drainage	UTM Location	Total	Adult	Sub Adult	Kid	Uncl.
Mt. Poia	35160/533790	12	8	2	2	
Mt. Poia	35060/533830	4	2	1	1	
Family Pk	34940/533460	11	5	2	3	1
Mt Field	35310/533020	1	1			
Mt Richmond	35560/533350	6	4		2	
Mt. Sentinel	35710/533140	6	4	1	1	
Lost Horse	35270/532780	3	2		1	
M Fk Birch	35330/532690	1	1			
Mt Drewyer	35570/532750	5	5			
Crooked Mtn	35830/532970	13	5	1	3	4
Mt. Drewyer	35670/532630	3	2		1	
Pinto Cr	35600/532450	3	3			
Crazy Cr	35920/532250	3	2		1	
South Cr	36470/532310	2	2			
Hoy Gulch	36620/532290	1	1			
Walling Reef	36530/533050	2	2			
Walling Reef	36600/532920	2	1		1	
Ear Mtn	37360/529770	4	3		1	
N Fk Deep Cr	37350/529150	2	1		1	
Miners Basin	36720/529070	4	2	2		
Erosion Gulch	36930/528960	1	1			
Erosion Gulch	36820/529060	1	1			
No Business	37220/528740	4	2		1	1
Castle Reef	37220/528120	1	1			
Miners Basin	36670/529340	2	2			
Rocky Mtn	36450/529660	2	2			
Hdq Pass	36440/529870	15			4	11
Ray Cr	36230/529870	1	1			
Old Baldy	36390/530150	10	5		2	3
Choteau Mtn	37200/531020	11	8	1	2	
Mt Werner	37020/531770	2	1		1	
Mt Frazier	36950/531910	4	2		1	1
Fright Cr	36540/532060	6	4	1	1	
Old Man/Hills	36820/532240	5	4		1	
Old Man/Hills	36770/532350	5	3	1	1	
Bruce Cr	36230/531860	6	4		2	
Bruce Cr	36040/531960	2	2			
Bruce Cr	36040/531930	1	1			
Jones Cr	36750/531170	7	3	1	3	
Mt Wright	36230/531330	1	1			
Mt Lockhart	36310/531100	2	1		1	
N Fk Teton	36470/530580	2	2			

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Appendix 24. Location and classification of mountain goats observed during helicopter survey of Rocky Mountain Front, July 11, 12 and 18, 1981.

Drainage	UTM Location	Total	Adult	Sub Adult	Kid	Uncl.
Family Pk	35030/533510	3	1	1	1	
Mt Field	35330/533100	1				1
Mt Field	35240/533070	2	1	1		
Mt Drewyer	35780/532630	5	2	2		1
Pat Gass	35950/532200	1				1
Bum Shot	36150/532550	1	1			
Walling Reef	36720/532770	2				2
Walling Reef	36610/532870	1	1			
Walling Reef	36670/532650	6	2	1	1	2
Walling Reef	36670/532650	5	2		1	2
N Fk Dupuyer	36340/532270	2				2
Old Man/Hills	36830/532330	3	1	1		1
S Fk Dupuyer	36630/531960	6	2	2	2	
S Fk Dupuyer	36640/531940	2	1		1	
S Fk Dupuyer	36570/532010	7	2	3	1	1
Mt Werner	36900/531710	2	1	1		
Choteau Mt	37110/531400	2	1	1		
Choteau Mt	37130/531400	1	1			
Choteau Mt	37230/530930	9	4	3	2	
Pat Gass	36020/532070	1	1			
S Fk Nanny	36060/531950	1	1			
S Fk Nanny	36150/531870	2	1	1		
Mt Wright	36010/531480	2	2			
Mt Wright	36020/531480	3	3			
Mt Wright	36040/531470	2	2			
Mt Wright	36040/531470	1	1			
Mt Lockhart	36160/531030	7	5		2	
Waldron Cr	36240/530870	4	3		1	
Cave Mtn	36960/530690	2	1		1	
Cave Mtn	36970/530680	1		1		
Rocky Mtn	36580/529720	4	2		2	
Ear Mtn	37230/529930	1	1			
Limestone Cr	35030/533760	1	1			
Scar Face	34950/533770	4	1	2	1	
Scar Face	35050/533870	2	1	1		
Morning Star	34850/533930	2	1	1		
Scar Face	35050/533840	1	1			
Spotted Eagle	34620/533930	3	2		1	
Spotted Eagle	34620/533920	4	2		2	
Spotted Eagle	34610/533910	6	3	1	2	
Spotted Eagle	34610/533910	1	1			
Curly Bear	34530/534040	3	1	1	1	
Badger Cr	34760/534180	3	1	1	1	
Slim Gulch	37050/529460	2	1		1	
S Fk Teton	36750/529550	2	2			
S Fk Teton	36430/529890	9	8		1	

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Appendix 25. Location and classification of mountain goats observed during helicopter survey of the Rocky Mountain Front, April 1982.

Drainage	UTM Location	Total	Adult	Sub-adult	Kid	Uncl.
Birch Cr.	3649/53333	2	2 M			
N Fk Birch	3543/53318	2	2			
N Fk Birch	3552/53325	7	2	2 Y	2	1
N Fk Birch	3565/53334	3	1	1 Y	1	
N Fk Dupuyer	3669/53255	1	1			
N Fk Dupuyer	3680/53247	1	1 M			
N Fk Dupuyer	3681/53230	1	1			
N Fk Teton	3676/53120	1	1 F			
E Fk N Fk Teton	3682/53157	2	1 F		1	
W Fk Teton	3622/53145	1	1 M			
M Fk Teton	3644/53026	2		2 Y		
S Fk Teton	3646/52984	14	5	2	5	2
Biggs Cr.	3655/52947	6	2	2	2	
S Fk Willow Cr.	3723/52993	5	2	1	2	

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Appendix 26. Location and classification of mountain goats observed during helicopter survey of the Rocky Mountain Front, July 1982.

Drainage	UTM Location	Total	Adult	Sub-adult	Kid	Uncl.
Badger-Limestone	3494/53397	4	2 F		2	
Badger-Limestone	3498/53389	1	1			
S Fk Badger	3418/53420	1	1 F			
N Fk Badger	3405/53427	1	1 M			
N Fk Badger	3404/53427	3	1 F		2	
S Fk Badger	3413/53425	1	1			
S Fk Badger	3415/53407	2	1 F		1	
S Fk Badger	3451/53410	7	3, 2 F		2	
S Fk Badger	3454/53411	2	2 M			
Badger-Lonesome	3497/53392	1	1			
Badger-Lonesome	3459/53391	5	2, 1 F	1	1	
S Fk Badger	3492/53350	1	1 M			
N Fk Birch	3494/53348	6	1, 2 F	1	2	
N Fk Birch	3503/53345	9	5, 2 F		2	
M Fk Flathead	3503/53321	1	1 M			
N Fk Birch	3508/53326	4	1 F, 1 M	2		
N Fk Birch	3514/53330	1		1		
N Fk Birch	3515/53333	2	1 F		1	
N Fk Birch	3514/53325	1	1 M			
M Fk Flathead	3519/53316	2	2 M			
M Fk Birch	3532/53302	3	1, 1 F	1		
M Fk Birch	3551/53341	5	2 F	1	2	
M Fk Birch	3553/53338	4	2 F		2	
M Fk Birch	3567/53279	3	2	1		
M Fk Birch	3582/53298	3	1 F		2	
M Fk Birch	3556/53258	1	1			
M Fk Birch	3563/53251	3	1 F		2	
S Fk Birch	3594/53225	1	1 M			
N Fk Dupuyer	3667/53274	1	1			
N Fk Dupuyer	3663/53258	2	2 M			
N Fk Dupuyer	3668/53259	9	8	1		
N Fk Dupuyer	3668/53258	5	1, 1 F	2	1	
N Fk Dupuyer	3677/53238	1	1 M			
S Fk Dupuyer	3665/53194	3	1 F	1	1	
S Fk Dupuyer	3666/53191	2	1, 1 M			
S Fk Dupuyer	3669/53184	1		1		
S Fk Dupuyer	3689/53200	1	1			
S Fk Dupuyer	3695/53199	6	2, 1 F	2	1	
S Fk Dupuyer	3693/53197	1	1 F			
Blackleaf Cr.	3696/53197	5	2, 1 F	1	1	
Muddy Cr.	3683/53157	3	1, 1 F		1	
Muddy Cr.	3708/53157	1	1 M			
Muddy Cr.	3711/53141	1	1 M			
S Fk Teton	3718/53033	1	1 F			
S Fk Teton	3637/53008	2	1 F		1	
S Fk Teton	3638/53015	3	2	1		
S Fk Teton	3643/52996	4	1 M, 1 F	2		
S Fk Teton	3641/52991	4	1 F	2	1	
S Fk Teton	3653/52969	1	1 F			
S Fk Teton	3664/52970	2	1 F		1	

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Appendix 26 continued.

Drainage	UTM Location	Total	Adult	Sub-adult	Kid	Uncl.
S Fk Teton	3678/53005	1	1 F			
S Fk Teton	3700/52985	1	1			
S Fk Teton	3707/52971	1	1			
N Fk Teton	3716/53127	2	1 F		1	
N Fk Teton	3713/53127	5	2 F	1	2	
N Fk Teton	3708/53129	4	3	1		
N Fk Teton	3711/53134	2	1, 1 M			
N Fk Teton	3712/53135	1	1 M			
N Fk Teton	3712/53137	2	1 F		1	
N Fk Teton	3629/53162	1	1			
N Fk Deep Cr.	3744/52897	3	1 F	2		
N Fk Deep Cr.	3726/52917	1	1 M			
N Fk Deep Cr.	3717/52917	1	1 M			
N Fk Deep Cr.	3733/52906	5	2 F	2	1	
S Fk Deep Cr.	3723/52875	5	2 F	2	1	
Sun River	3718/52788	1	1			
Sun River	3672/52938	1	1 M			
Sun River	3646/52980	5	2 F	1	2	
Sun River	3619/52989	1	1 M			
Sun River	3635/53015	1	1 M			
Sun River	3595/53067	11	7, 1 F	2	1	

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Appendix 27. Location and classification of mountain goats observed during helicopter survey of Rocky Mountain Front, July 1983.

Drainage	UTM Location	Total	Adult Male	Adult Female	Adult Unk	Sub Adult 1	Sub Adult 2	Sub Adult Unk	Kid	Uncl.
Steep Cr	35030/533740	1	1							
Steep Cr	35130/533690	2	1				1			
S Fk Badger	34540/534010	4		2					2	
Lonesome Cr	34560/533980	13		4	1			4	4	
Lonesome Cr	34550/534020	10		3	4			2	1	
Lonesome Cr	34560/534010	3		1				1	1	
S Fk Badger	34525/534110	6		2	1			1	2	
Lonesome Cr	34530/534470	1	1							
Lonesome Cr	34870/533950	2	2							
Lonesome Cr	34850/534050	1			1					
Limestone Cr	35000/533830	2		1				1		
S Fk Badger	34120/534250	5		3					2	
Kip Cr	34060/534280	2		1					1	
Kip Cr	33550/534350	3		1	1				1	
N Fk Birch	35140/533380	2		1					1	
Blind Cr	35130/533250	16		4	3			5	4	
Blind Cr	35250/533140	2		1					1	
Blind Cr	35250/533140	2		1				1		
Lost Horse Cr	35230/533060	1	1							
Lost Horse Cr	35160/532970	1	1							
Gateway Cr	35480/532490	1	1							
Nanny Cr	36020/532130	2			2					
Circus Cr	35940/532230	1	1							
Circus Cr	35980/532170	1			1					
Canyon Cr	36640/532640	2	2[1/]							
Sheep Cr	36600/532880	2		1	1					
N Fk Dupuyer	36680/532580	2	1			1				
N Fk Dupuyer	36670/532550	1						1		
N Fk Dupuyer	36690/532640	1		1						
N Fk Dupuyer	36770/532660	2		1					1	
N Fk Dupuyer	36320/532330	1	1							
S Fk Dupuyer	36800/532350	5		2	1				2	
Rival Cr	36650/531950	1		1[2/]						
Rival Cr	36650/531960	1		1						
Rival Cr	36640/531990	1	1							
S Fk Dupuyer	36950/531990	5		3[3/]	1		1			
Nanny Cr	36030/532140	2			2					
Bruce Cr	36120/531870	4			3			1		
Bruce Cr	36220/531880	2		1				1		
Bruce Cr	36210/531870	1		1						
Bruce Cr	36120/531860	1	1							
Bruce Cr	36100/531810	1			1					
Jones Cr	37040/531410	1			1					
Jones Cr	37050/531420	1		1[4/]						
Bruce Cr	36190/531450	1	1							

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Appendix 27. continued

Drainage	UTM Location	Total	Adult Male	Adult Female	Adult Unk	Sub Adult 1	Sub Adult 2	Sub Adult Unk	Kid	Uncl.
W Fk Teton	35980/531490	1			1					
M Fk Teton	36370/530160	2			2					
Route Cr	36340/530150	1			1					
S Fk Teton	36440/530170	1			1					
S Fk Teton	36450/530170	2	2							
Nesbit Cr	35925/530630	6		3				1	2	
Headquarters	36390/529870	15		5	3			3	4	
South Cr	36640/529650	9		4[5/]	2			3		
South Cr	36640/529760	1			1					
South Cr	36620/529750	2			2					
S Fk Teton	36620/529810	1			1					
South Cr	36730/529540	1			1					
S Fk Willow	37230/529750	8		3	1	2			2	
N Fk Deep	37380/529070	1		1						
N Fk Deep	37170/529160	2		1				1		
No Business	37120/528590	1	1							
S Fk Deep	37240/528720	4			2			2		
Ray Cr	36080/529830	2		2						
Ray Cr	36190/529880	2			2					
Total		184	19	57	44	3	2	28	31	

[1/] Radio collar 7881, 5 year male
[2/] Neckband blue and white no. 32, adult female
[3/] Neckband red and white no. 42, 6 year female, radio collar 2302, adult female; radio collar 2402, 3 year female
[4/] Radio collar 2902, adult female
[5/] Radio collar 2202, adult female

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Appendix 28. Location and classification of mountain goats observed during helicopter survey of North Fork Dupuyer to South Fork Teton portion of the Rocky Mountain Front, April 30 and May 1, 1984

				Adult		Sub Adult				
Drainage	UTM Location	Total	Male	Female	Unk	1	2	Unk	Kid	Uncl.
Sheep Cr	36520/533270	2	2							
Scoffin Cr	36690/532830	1			1					
Canyon Cr	36670/532590	1	1							
N Fk Dupuyer	36770/532430	1		1						
S Fk Dupuyer	37060/532280	3		2[1]					1	
Cow Cr	37170/532080	1	1[2]							
Muddy Cr	37070/531640	1	1[3]							
Blackleaf Cr	37290/531790	1	1							
Blackleaf Cr	36960/531730	2		1[4]			1			
Blackleaf Cr	36940/531720	2		2[5]						
Muddy Cr	37080/531480	1	1[6]							
Jones Cr	37130/531240	1		1						
Jones Cr	37090/531260	3		1		1			1	
Jones Cr	36790/531160	1		1						
E Fk Teton	36630/531930	1	1[7]							
Nanny Cr	36120/532120	2	2							
Bruce Cr	36100/531800	4	1	2		1				
N Fk Teton	36330/531490	5	1	3		1				
M Fk Teton	36380/530450	8		5		2			1	
S Fk Teton	36480/530220	5		3		1			1	
S Fk Teton	36540/530000	1			1					
S Fk Teton	36440/529850	11		7		1	1		2	
S Fk Teton	36450/529860	2	2							
Total		60	14	29	2	7	2		6	

[1] Neckband blue and white no. 32 adult female
[2] Radio collar 8612 adult male
[3] Radio collar 2692 adult male
[4] Radio collar 2302 adult female
[5] Radio collar 2402, 3 year female and neckband red and white no. 42, 6 year female
[6] Radio collar 7082 adult male
[7] Neckband black and yellow no. 19, 6 year male

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Appendix 29. Location and classification of mountain goats observed during helicopter survey of the Rocky Mountain Front, July 1984.

Drainage	UTM Location	Total	Adult	Subadult 1	Subadult 2	Kid	Uncl.
N Fk Birch	34930/533430	2	1F		1		
N Fk Birch	34970/533510	1	1F				
Lonesome	34640/533880	9	6F,3				
S Fk Badger	34500/533980	1	1M				
Lonesome	34550/534060	2	2				
Lonesome	34560/534050	11	8F	1		2	
Lonesome	34540/533970	3	2F			1	
Lonesome	34830/534070	2	2M				
Limestone	34930/533950	1	1M				
Small	35080/533840	2	1F			1	
N Fk Badger	34070/534260	2	2F				
N Fk Badger	34100/534280	2	2F				
N Fk Birch	34920/533380	2		2			
Kid	36350/532240	1	1M[1/]				
Muddy	37020/531520	2	2M[2/]				
Blindhorse	37150/531240	2	1F[3/]	1			
Jones	37100/531350	7	4F	1	1	1	
Jones	37060/531440	2	2M				
Bruce	36110/531880	1	1F				
Wright	35990/531550	3	2M[4/],1F				
W Fk Teton	36000/531470	6	1M,2F		2	1	
W Fk Teton	36000/531420	2	2M[5/]				
Blackleaf	36990/531930	8	6F,1			1	
N Fk Dupuyer	36690/532640	19	1M,5F[6/],7	2	2	2	
N Fk Dupuyer	36720/532430	1	1M[7/]				
N Fk Dupuyer	36340/532260	1	1M[8/]				
N Fk Teton	36020/532150	2	1F			1	
N Fk Birch	35140/533370	2	2F				
N Fk Birch	35210/533400	1	1M				
N Fk Birch	35210/533380	1			1		
Blind	35140/533320	1	1				
Lost Horse	35260/533060	1	1				
Lost Horse	35240/533060	1	1F				
Pinky	35720/532740	8	2F,2	2	2		
My	35760/532160	1	1M[9/]				

1/ Radio collar 1861, adult male
2/ Radio collar, identifying symbols gone
3/ Radio collar 829, 9 year female
4/ Neckband #52, black with yellow stripe, adult female
5/ Neckband #42, red with white hollow rectangles, 8 year female
Radio collar 2302, adult female
Radio collar 2402, 4 year female
Radio collar 1729, 9 year female
6/ Neckband #32, blue with white circles and squares, adult female
7/ Radio collar 7082, adult male
8/ Neckband #19, black with yellow diamonds, 7 year male
9/ Neckband #29, black with yellow blimps, 7 year male

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Appendix 30. Location and classification of mountain goats observed during helicopter survey of the Rocky Mountain Front, December 1984.

Drainage	UTM Location	Total	Adult	Subadult	Kid	Uncl.
N Fk Birch	35120/533330	2	2			
Blind	35470/533420	2	2			
Pinky	35830/532940	17	4F,9	3	1	
S Fk Birch	35850/532910	1	1M			
S Fk Birch	35840/532910	2	2M			
M Fk Birch	35770/533000	1	1			
Phone	36140/532490	3	1M[1/],1F		1	
Phone	36150/532500	2	2M[2/]			
S Fk Badger	36150/532500	1	1M			

1/ Radio collar 7881, 6 year male
2/ Radio collar 6982, adult male

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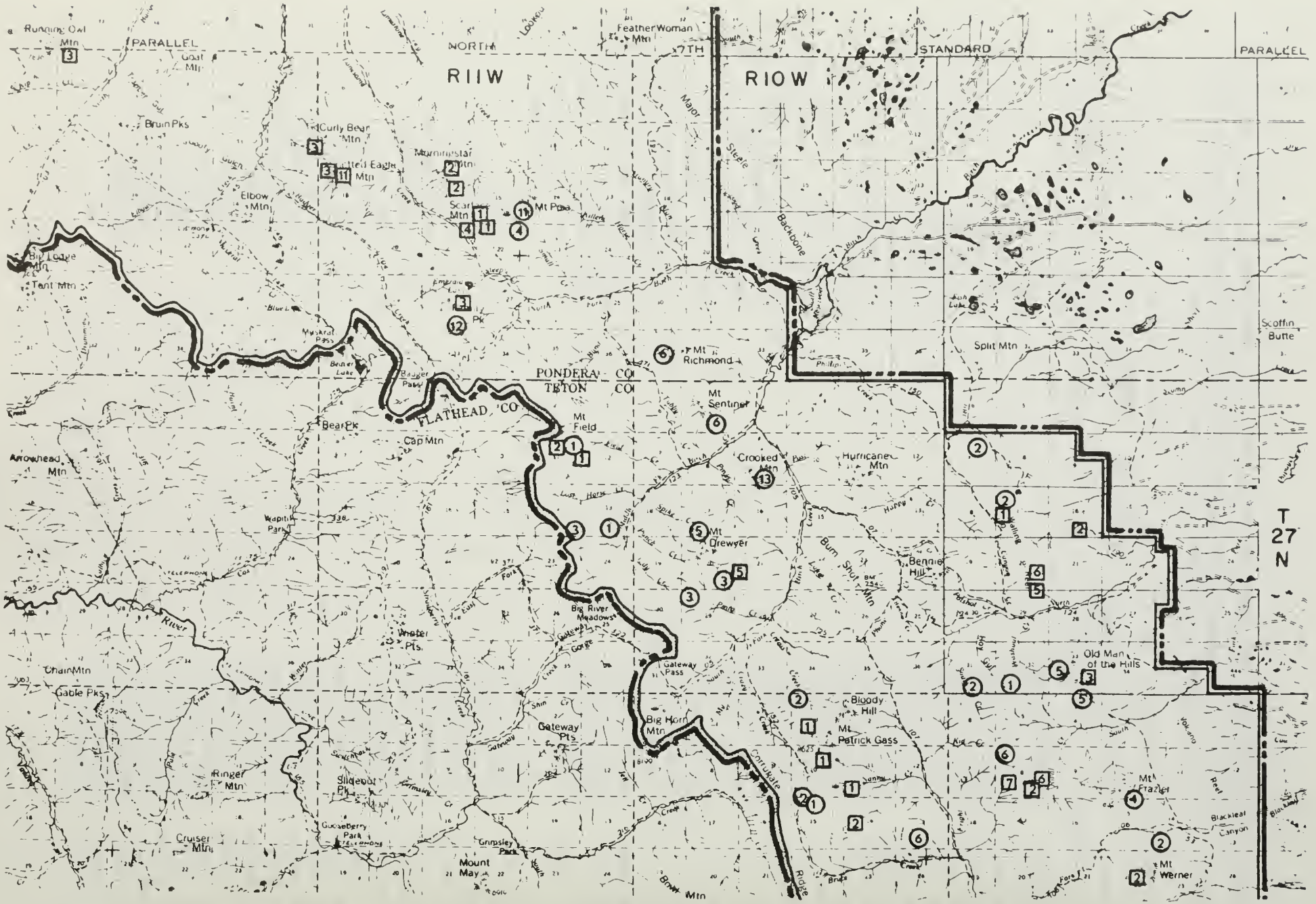
Appendix 31. Location and classification of mountain goats observed during helicopter survey of the area east of the Continental Divide, north of the Middle Fork Teton to South Fork Birch Creek, July 13, 1985.

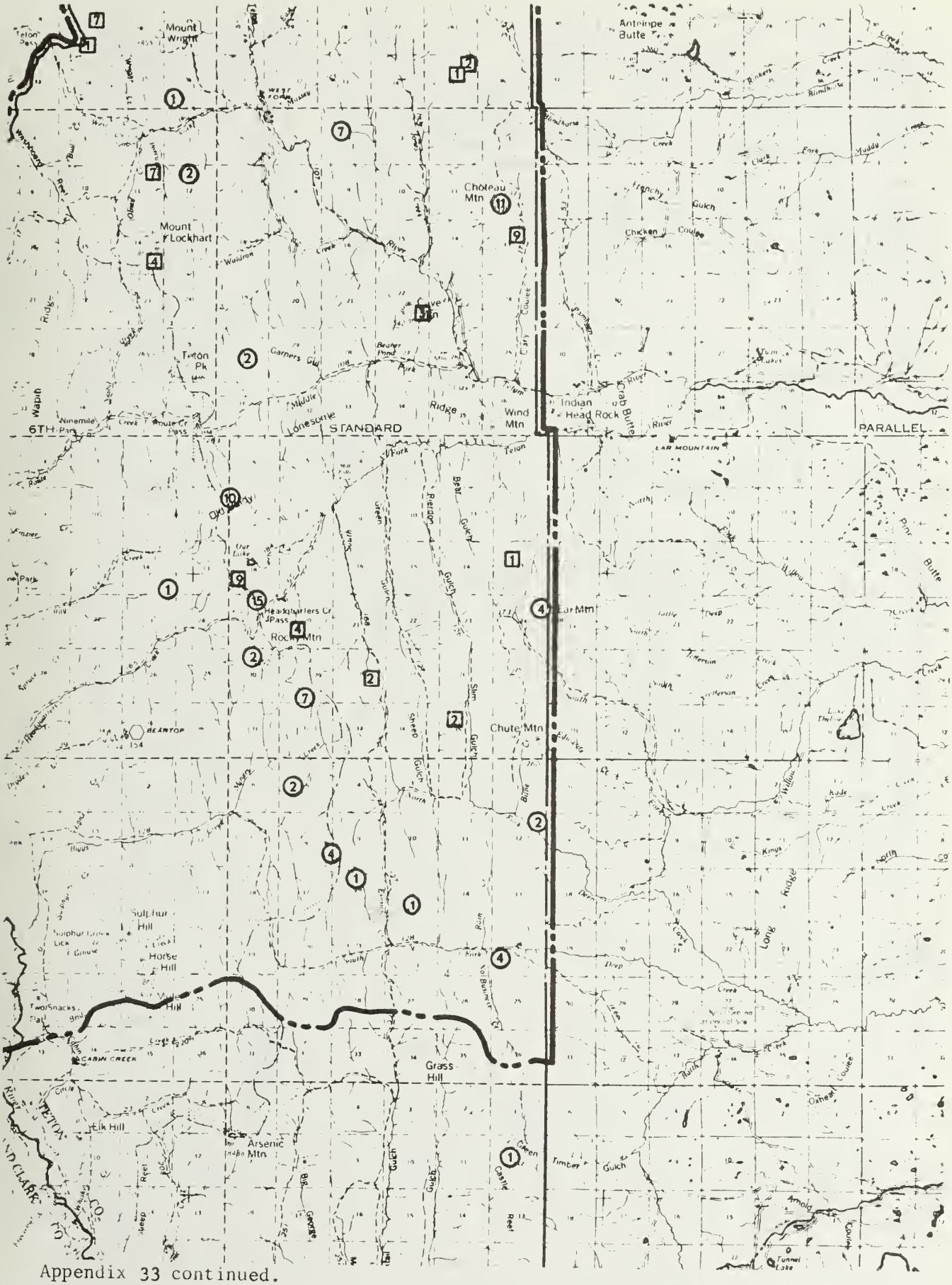
Drainage	UTM Location	Total	Adult			Subadult			Kid	Comments
			M	F	Un	1	2	Un		
Blackleaf	37030/531930	3		2	1					#42
Blackleaf	37020/531930	1		1						#2402
Blackleaf	36990/531970	2		1					1	#32
Annie Gulch	37080/531470	1		1						#2692-?
Blindhorse	37190/531260	4	1	1		1	1			
Blindhorse	37220/531310	3		2					1	
Jones	37110/531350	1	1							
Jones	37120/531220	1		1						
Jones	37100/531410	1	1							
EFNF Teton	36600/531760	1	1							
EFNF Teton	36560/531760	1	1							
NF Dupuyer	36270/532380	1	1							#8612-?
NF Dupuyer	36350/532320	3		2					1	
NF Dupuyer	36330/532320	3	2					1		
Washout	36720/532320	2	2							#7082 & #3042
Scoffin	36690/532710	1		1						
Nanny	36100/532140	1		1						
Wright	36000/531450	4	2	1	1					
Olney	35960/530980	1		1						
Waldron	36240/530640	2		1					1	

Appendix 32. Location and classification of mountain goats observed during helicopter survey of the area east of the Continental Divide, north of the Middle Fork Teton to Highway 2, June 17-18, 1986.

Drainage	UTM Location	Total	Adult			Subadult			Kid	Comments
			M	F	Un	1	2	Un		
Blind Cr	235590/533320	2		1					1	
Blind Cr	235150/533320	1	1							
N FK Birch	235180/533450	2		1					1	
N FK Birch	235110/533340	1	1							
N FK Birch	235090/533310	3		2		1				
N FK Birch	235030/533290	2		1			1			
Lost Horse	235300/532780	5	2	1			1		1	
M FK Birch	235400/532640	1	1							
S FK Birch	235680/532690	6		3		2	1			Mt. Drewyer
Circus Cr	236020/532200	1	1							
Circus Cr	236010/532200	1	1							
Nanny Cr	236050/531990	2	2							
Trail Cr	235820/532040	1	1							Corrugate Ridge
Olney Cr	236150/530960	1		1						Mt. Lockhart
Frenchy Cr	237320/531040	3		2					1	
Jones Cr	237130/531050	1		1						M. Washington
Jones Cr	237160/531210	3		1			1		1	M. Washington
Jones Cr	237080/531420	1	1							Squaretop
Rival Cr	236830/531940	6	2	3		1				2402, Frazier
N FK Dupy	236760/532420	1		1						Old Man Hills
Washout Cr	236580/532370	1		1						
Kid Cr	236350/532150	1	1							
E FK Teton	236860/531920	1	1							39 orange neck-band
Nesbit Cr	236190/530470	12		6			2	2	2	Lick
Small Cr	235160/533790	1	1							Poia
Steep Cr	234970/533450	2	2							Family Pk
S FK Badger	234900/533420	3	3							Family Pk
Lonesome Cr	234860/534030	1	1							Morningstar
Limestone Cr	234930/533950	2		1					1	Morningstar
Limestone Cr	235040/533830	5		4				1		Scarface
S FK Badger	234510/534110	12	2	5		2			3	Curly Bear
S FK Badger	234540/534160	4		2					2	Curly Bear
S FK Badger	234540/534020	5		3		1			1	Curly Bear
S FK Badger	234540/533990	1		1						Curly Bear
S FK Badger	234550/533900	3	3							Spotted Eagle
S FK Badger	234120/534250	2		1		1				Goat Mtn
S FK Badger	234130/534300	4		2			1		1	Goat Mtn
Slip. Hoof	234430/534950	1	1							Half Dome
N FK Dupuy	236710/532690	1	1							Walling
N FK Dupuy	236680/532610	6		3		1	2			Walling
Canyon Cr	236650/532740	2		1			1			Walling
N FK Dupuy	236760/532640	1	1							Walling
N FK Dupuy	236240/532410	1		1						
Hoy Gulch	236580/532270	1	1							

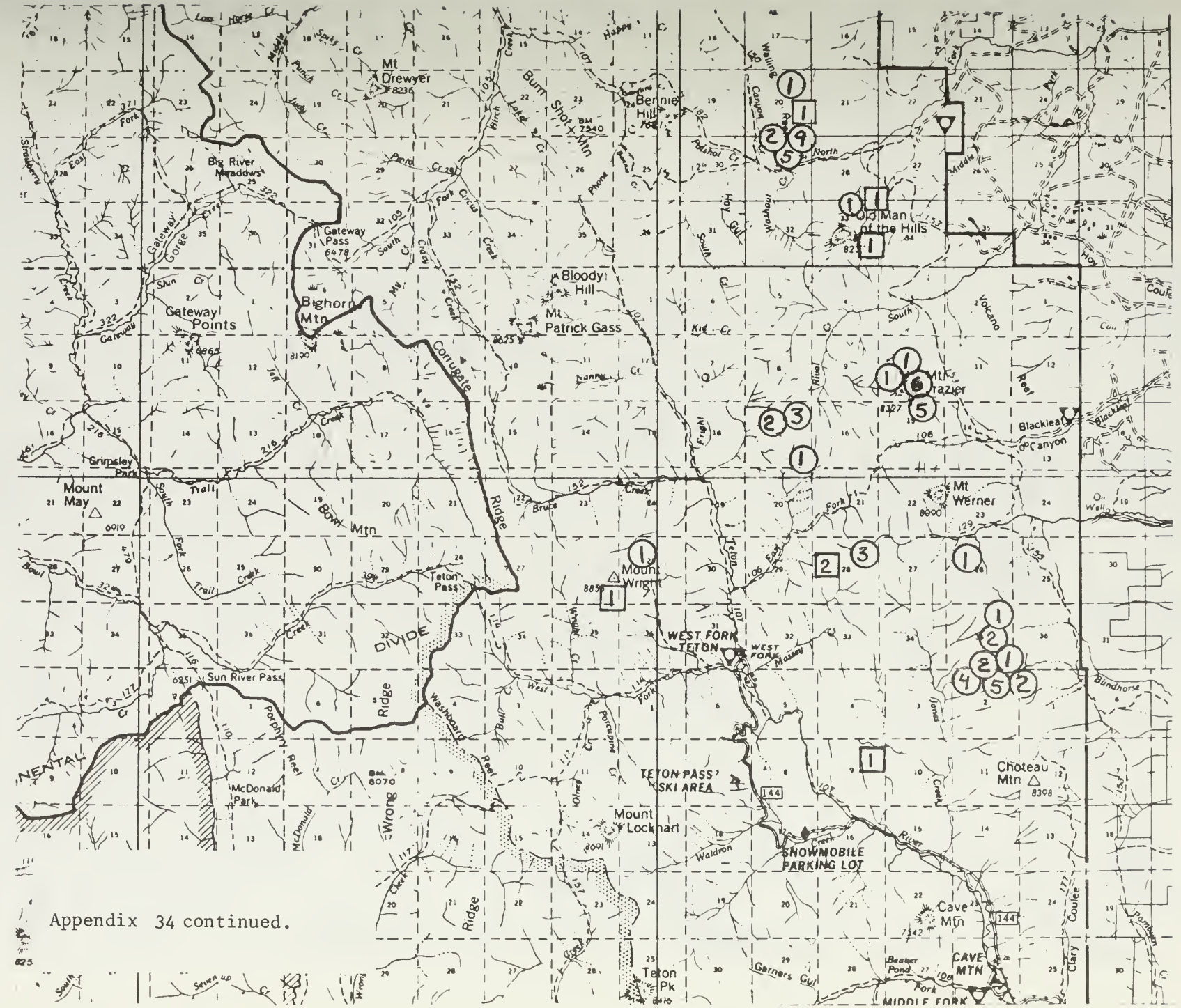


Appendix 33. Locations of mountain goats observed within the Rocky Mountain Front study area during the March (circles) and July (squares) 1981, helicopter surveys.

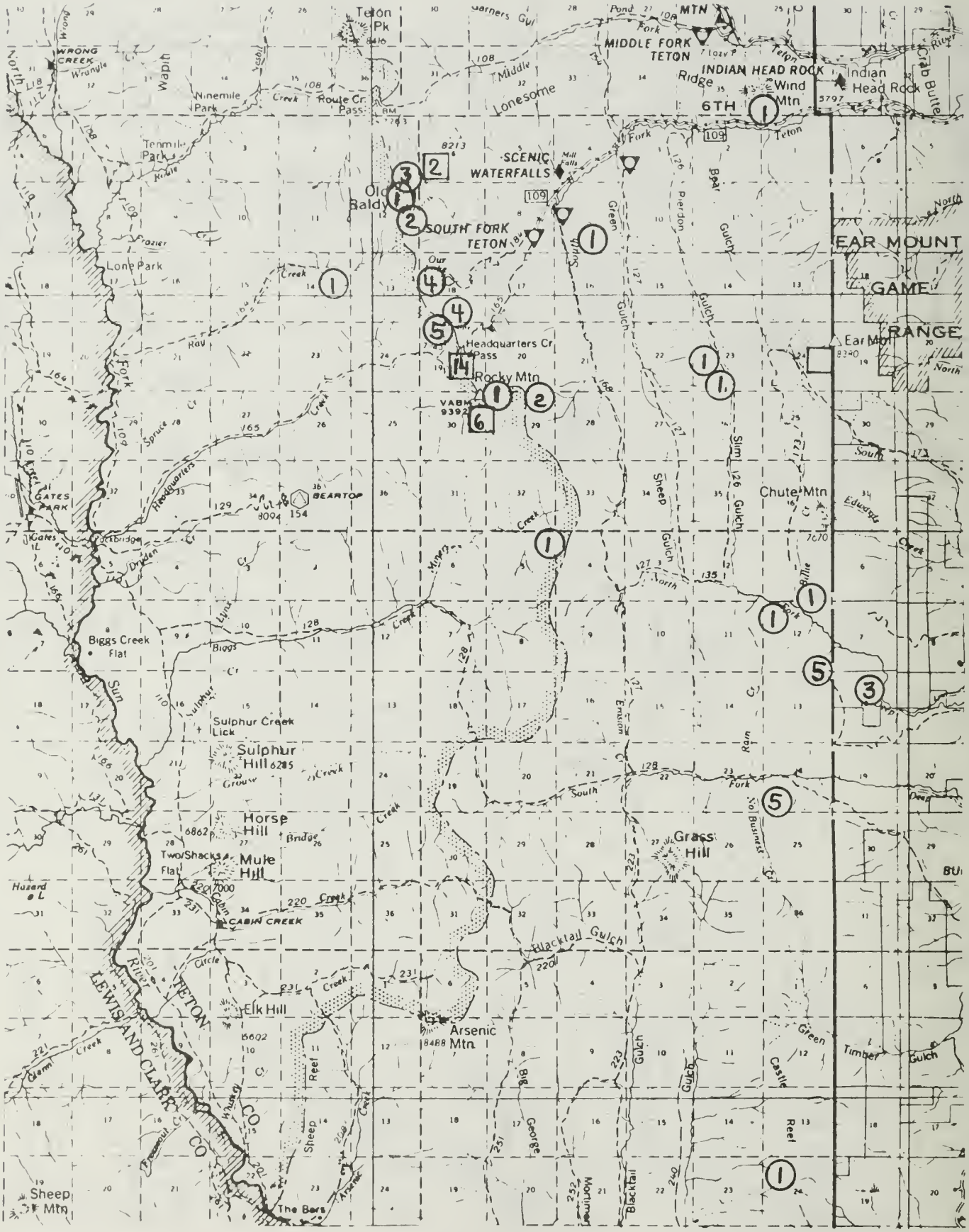


Appendix 33 continued.

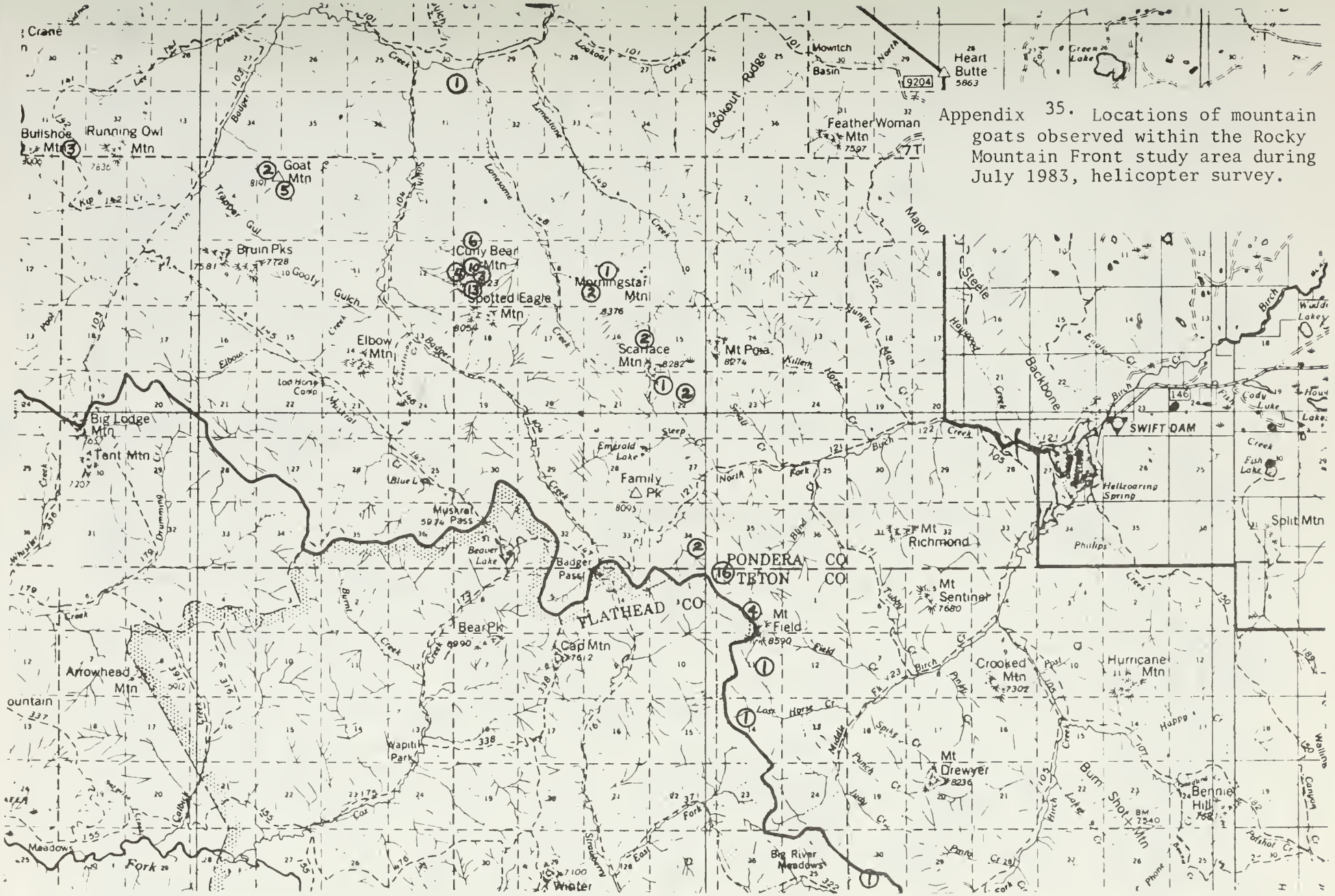
Appendix 34. Locations of mountain goats observed with the Rocky Mountain Front study area during April (squares) and July (circles) 1982, helicopter surveys.



Appendix 34 continued.

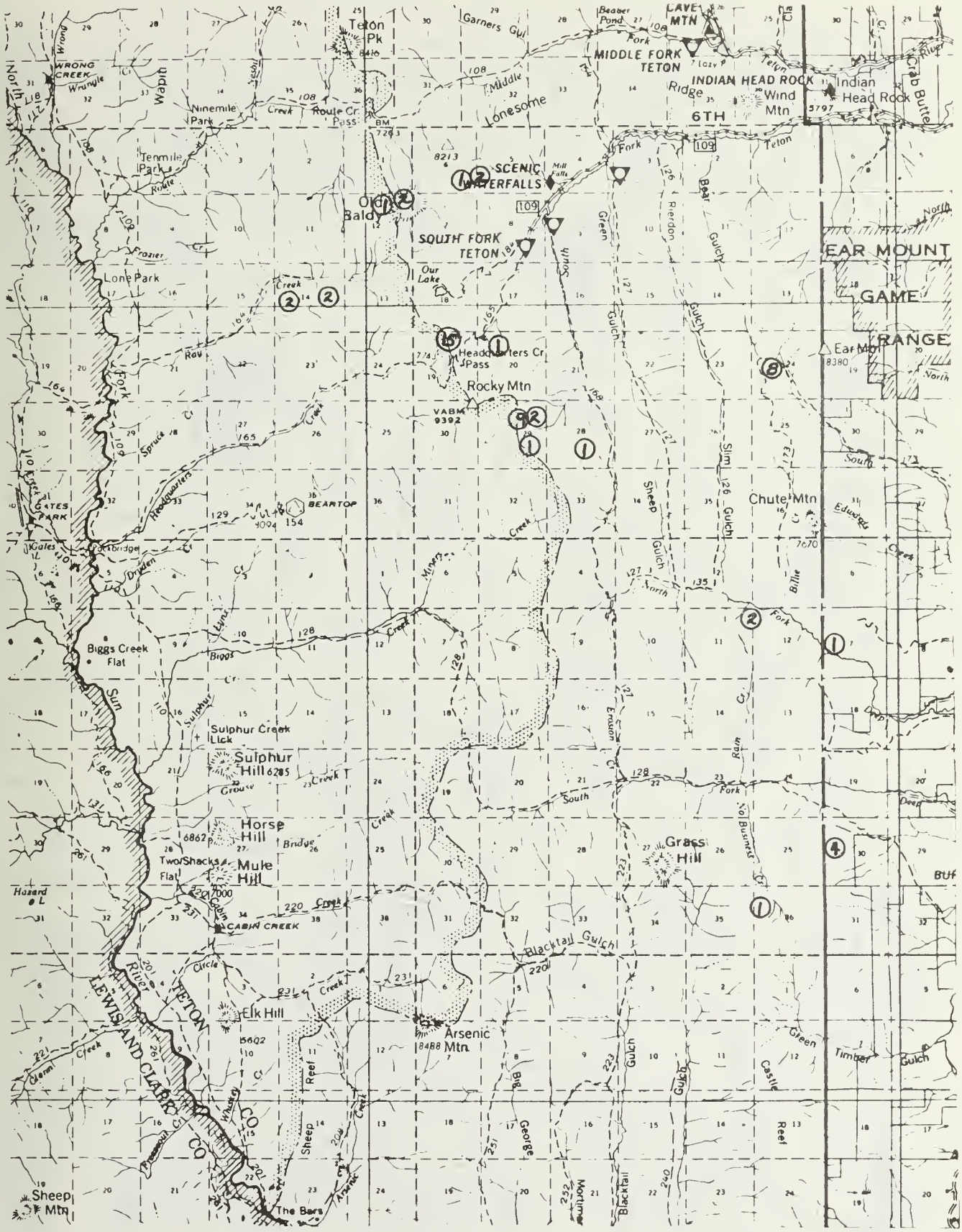


Appendix 34 continued.



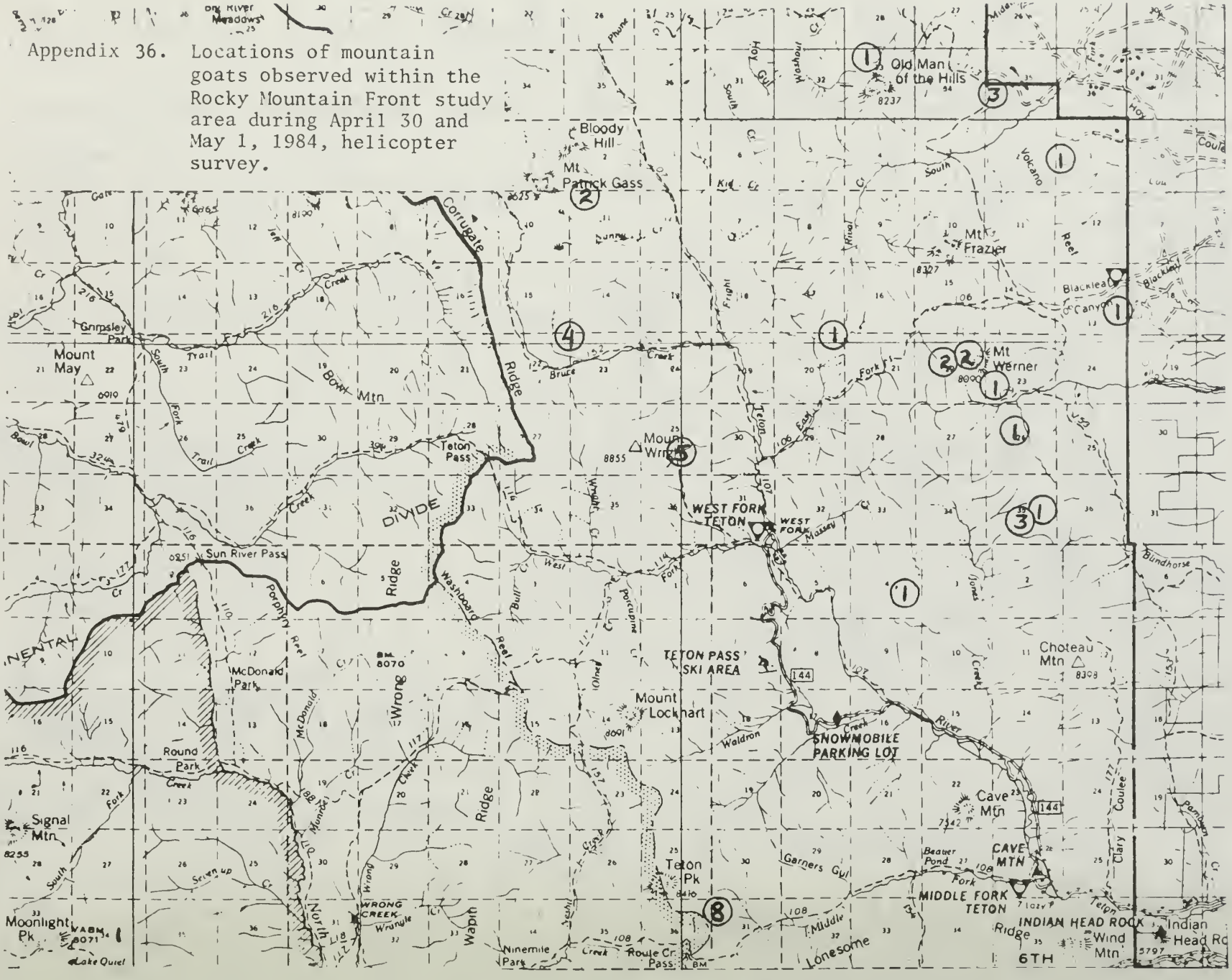
Appendix 35. Locations of mountain goats observed within the Rocky Mountain Front study area during July 1983, helicopter survey.

Appendix 35.continued.

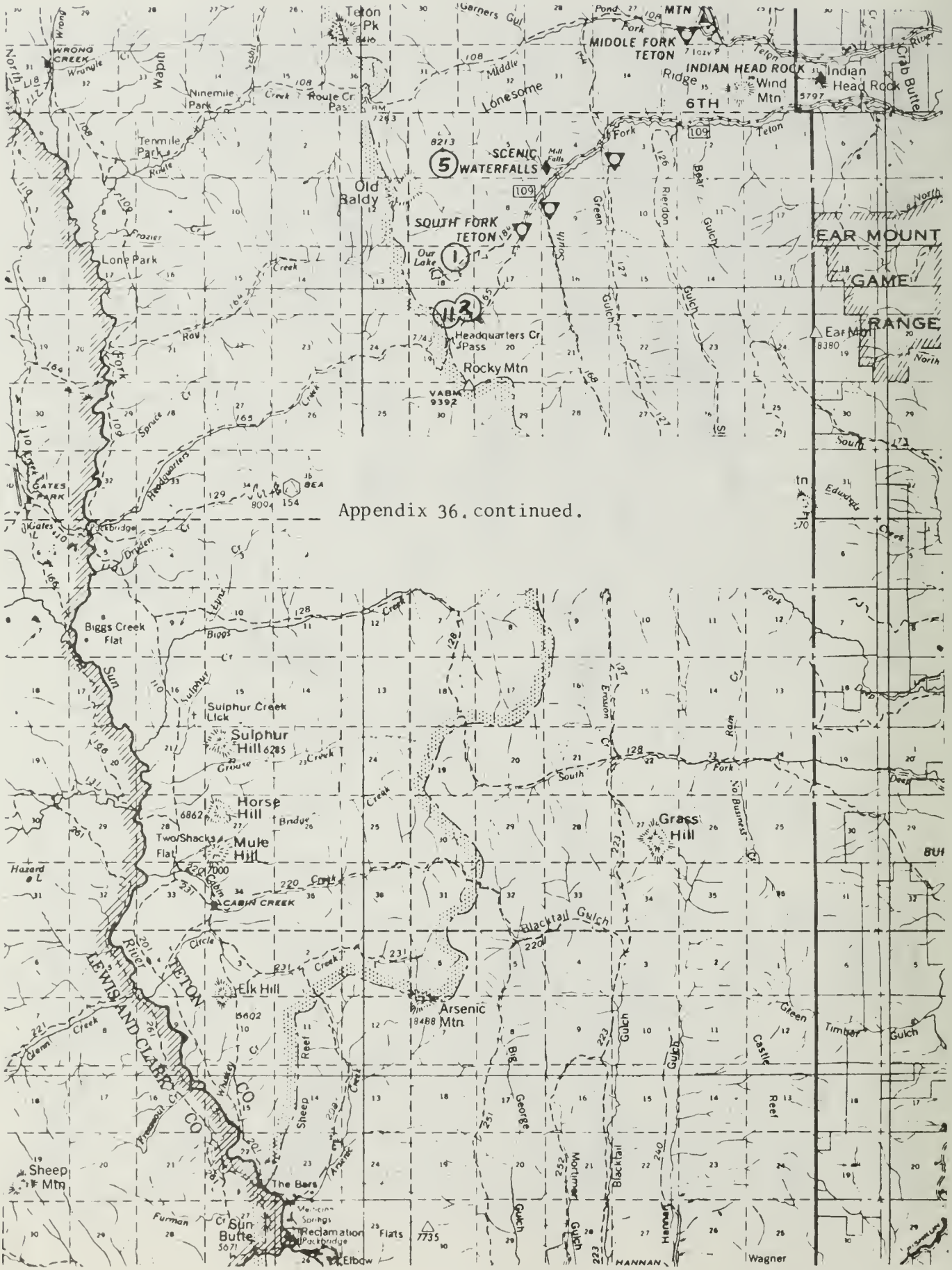


Appendix 35.continued.

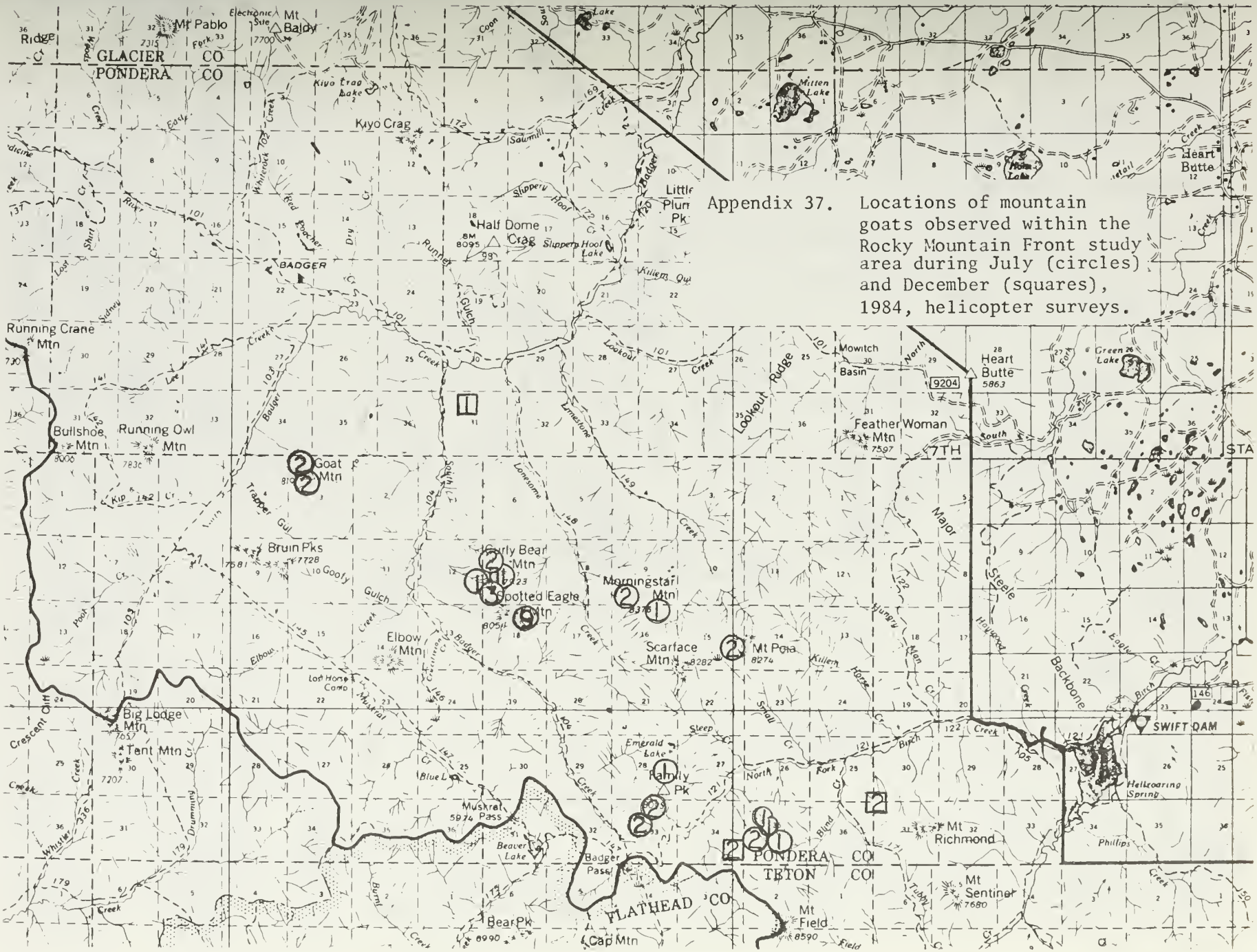
Appendix 36. Locations of mountain goats observed within the Rocky Mountain Front study area during April 30 and May 1, 1984, helicopter survey.



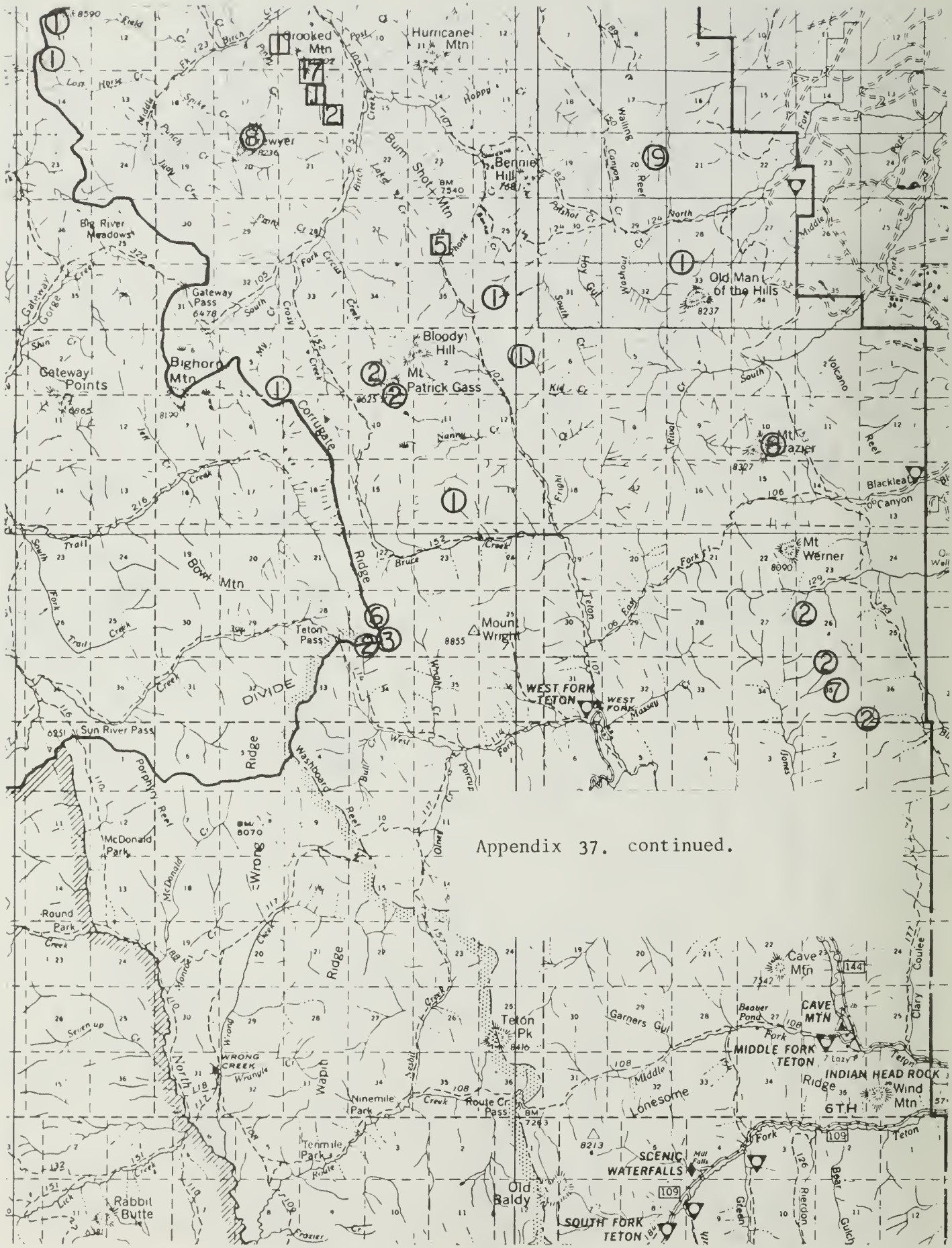
Appendix 36. continued.



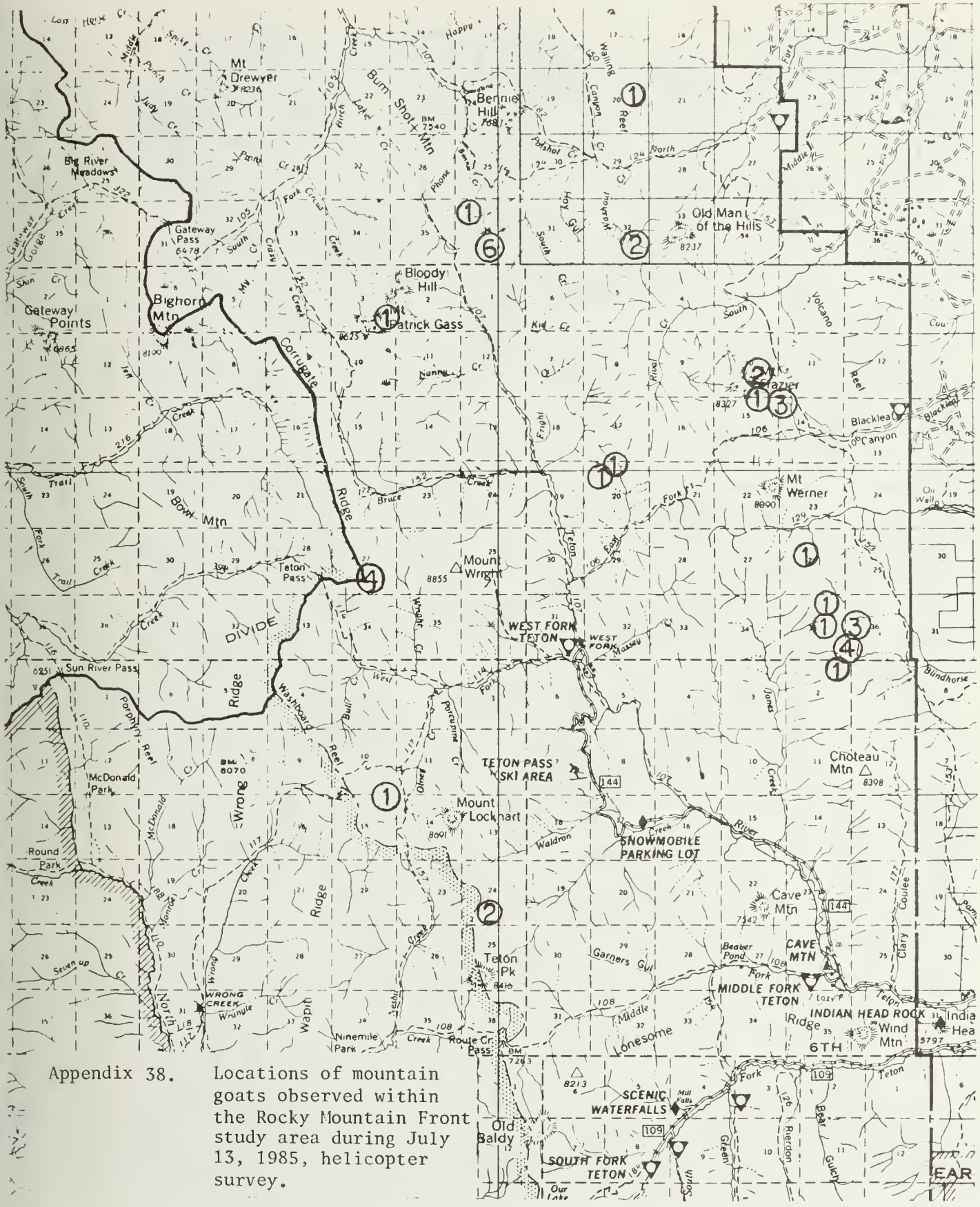
Appendix 36. continued.



Appendix 37. Locations of mountain goats observed within the Rocky Mountain Front study area during July (circles) and December (squares), 1984, helicopter surveys.

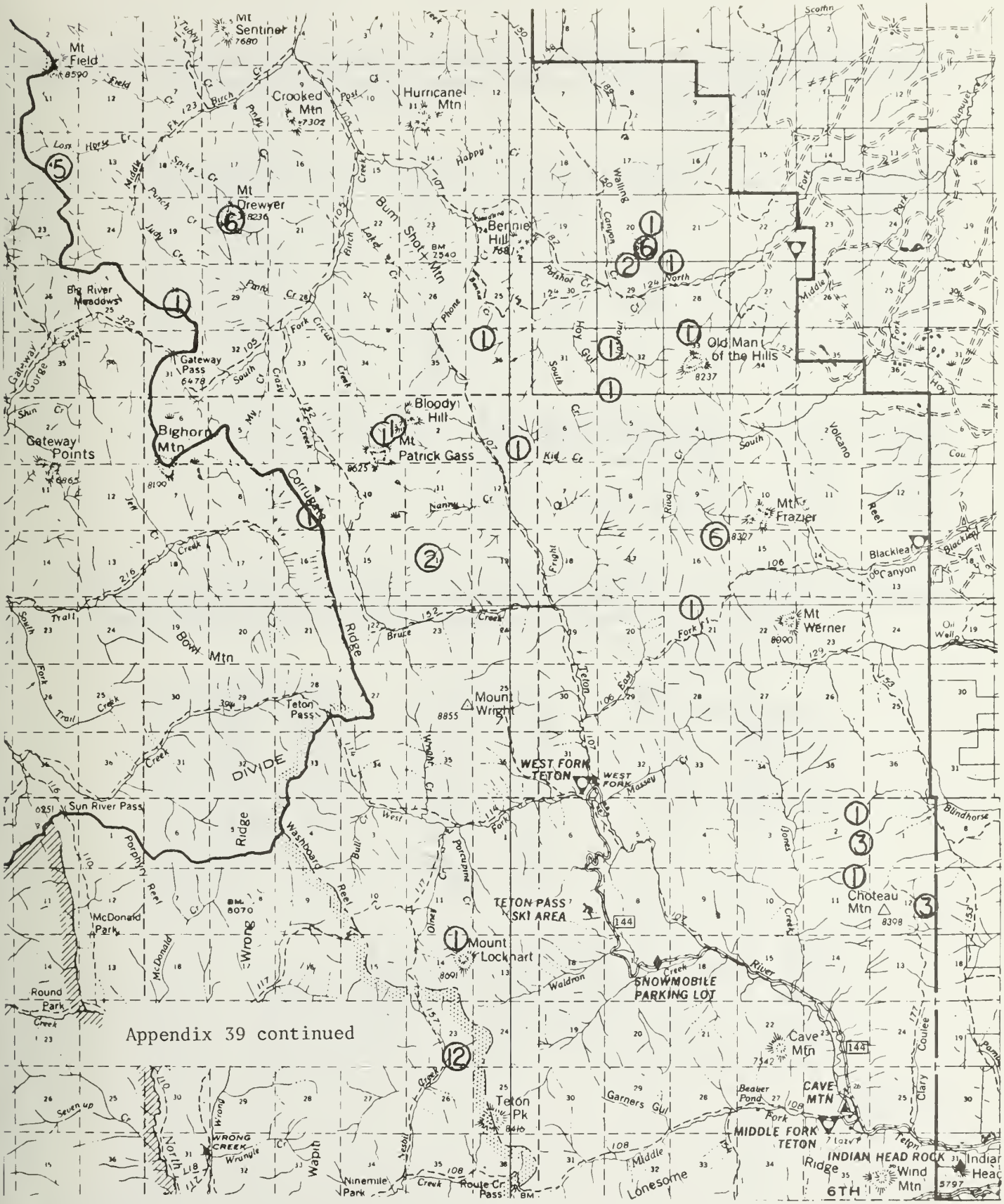


Appendix 37. continued.



Appendix 38. Locations of mountain goats observed within the Rocky Mountain Front study area during July 13, 1985, helicopter survey.

Appendix 39. Locations of mountain goats observed within the Rocky Mountain Front study area during June 17-18, 1986, helicopter survey.



Appendix 39 continued

Appendix 40. Frequency distribution of habitat parameters existing within a portion of the Rocky Mountain Front mountain goat study area, based on 1463 random points.

Elevation(m)	%
1524-1676	3.1
1676-1829	12.4
1829-1981	26.9
1981-2134	23.5
2134-2286	22.4
2286-2438	9.1
2438-2590	2.1
2590-2743	0.5

Aspect	%
N	10.8
NE	13.1
E	15.7
SE	13.7
S	8.0
SW	13.9
W	16.1
NW	8.8

Landtype Code	%	Code	%	Code	%
12	.4	72	.1	III	1.9
13A	.2	160	.2	IIIa	.4
14D	1.3	161	.9	IV	.1
18	3.2	171	.9	Va	1.1
20	.2	181	1.7	Vb	2.1
21A	1.4	182	7.2	Vc	2.8
22	1.6	183	.3	Vd	1.7
23A	.4	200	1.1	Ve	29.4
25	4.8	202	12.6	VI	.1
25B	.1	I	.2	VII	4.7
25C	1.2	Ib	.6	VIIa	.8
71	6.9	II	.6	VIII	6.7

Slope	%
90± %	3.3
70-89	15.4
30-69	66.2
10-29	12.0
0-9	3.0

Distance to Road	%
Less than 0.4 km	5.8
0.4-0.8 km	6.1
0.8-1.6 km	10.6
Over 1.6 km	77.5

Appendix 41. Frequency distribution of habitat parameters on the Rocky Mountain Front used by mountain goats during the kidding-nursery period, based on 153 observation points.

Elevation(m)	%
1829-1981	11.0
1981-2134	14.0
2134-2286	44.1
2286-2438	27.9
2438-2590	2.9

Aspect	%
N	8.7
NE	5.8
E	43.5
SE	10.1
S	10.1
SW	3.6
W	7.2
NW	5.8
Flat	5.1

Landtype Code	%
71	1.4
161	.7
171	12.8
182	.7
202	64.5
VI	19.9

Slope	%
± 90 %	26.3
70-89	58.4
30-69	9.5
10-29	3.6
0-9	2.2

Distance to Road	%
Less than 0.4 km	4.3
0.4-0.8 km	-
0.8-1.6 km	2.6
Over 1.6 km	93.1

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Appendix 42. Frequency distribution of habitat parameters on the Rocky Mountain Front used by mountain goats during the breeding period, based on 266 observation points.

Elevation(m)	- %
1676-1829	.9
1829-1981	5.1
1981-2134	11.2
2134-2286	42.3
2286-2438	32.6
2438-2590	7.0
2590-2743	.9

Aspect	- %
N	7.2
NE	13.9
E	32.5
SE	19.1
S	7.7
SW	5.7
W	5.7
NW	7.2
Flat	1.0

Landtype Code	%
30	.4
71	.8
171	1.6
181	.4
182	13.3
202	64.3
VI	19.2

Slope	- %
± 90 %	39.9
70-89	38.4
30-69	20.7
10-29	1.0
0-9	-

Distance to Road	- %
Less than 0.4 km	.7
0.4-0.8 km	2.2
0.8-1.6 km	2.2
Over 1.6 km	94.8

Appendix 43. Frequency distribution of habitat parameters on the Rocky Mountain Front used by mountain goats yearlong, based on 2237 observation points.

Elevation(m)	- %
1219-1524	.1
1524-1676	.2
1676-1829	.8
1829-1981	9.3
1981-2134	14.9
2134-2286	35.3
2286-2438	30.1
2438-2590	8.0
2590-2743	1.2
2743-2895	.2

Aspect	- %
N	9.4
NE	14.4
E	31.0
SE	13.7
S	9.7
SW	7.7
W	6.7
NW	4.6
Flat	2.9

Landtype Code	%
18	1.0
23	.01
25	.1
25A	.01
30	.01
61	.01
63B	.1
66	.01
71	.6
161	.1
171	5.0
181	.4
182	6.0
183	.4
200	.01
201	.01
202	57.1
203	.01
Va	.01
Vd	.01
VI	27.8
VII	.8

Slope	- %
± 90 %	31.2
70-89	44.6
30-69	19.9
10-29	1.4
0-9	2.9

Distance to Road	- %
Less than 0.4 km	2.2
0.4-0.8 km	1.1
0.8-1.6 km	3.4
Over 1.6 km	93.4

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Appendix 44. Location and description of mountain goat feeding sites examined during 1981.

DATE		LOCATION T	R	S	DRAINAGE	ELEVATION (Feet)	ASPECT
March	15	26N	10W	25	W Fk, N Fk Teton	7450	SW
	15	26N	10W	25	W Fk, N Fk Teton	7400	SW
	16	25N	9W	12	Jones Cr	8200	SW
	28	25N	9W	14	Jones Cr	7700	W
	28	25N	9W	14	Jones Cr	7650	S
April	2	25N	9W	34SW	S Fk Teton	6000	SW
	2	25N	9W	34SW	S Fk Teton	6100	SW
	11	25N	9W	26	M Fk Teton	6400	E
	30	26N	9W	10	Blackleaf Cr	6600	SE
May	23	25N	9W	34SW	S Fk Teton	6400	S
	24	26N	9W	10	Blackleaf Cr	6400	SE
	25	26N	9W	10	Blackleaf Cr	6600	SE
	25	26N	9W	11	Blackleaf Cr	6900	SE
	25	26N	9W	10	Blackleaf Cr	6300	S
June	2	27N	9W	35SE	S Fk Dupuyer	6200	SE
	5	26N	9W	14NW	Blackleaf Cr	6000	SE
	5	26N	9W	15	Blackleaf Cr	6400	SE
	5	26N	9W	10	Blackleaf Cr	6800	E
	22	25N	9W	7SW	Frenchy Gulch	6800	SE
July	5	25N	9W	1	Blindhorse	7700	E
	5	25N	9W	1	Blindhorse	7700	E
	22	24N	9W	20SW	S Fk Teton	7200	E
	22	24N	9W	20NW	S Fk Teton	7000	NE
	27	26N	9W	10	Blackleaf Cr	6800	E
August	19	26N	9W	15NW	Blackleaf Cr	7200	SE
	20	24N	9W	19	Headquarters Cr	7700	N
	20	24N	9W	19	S Fk Teton	7700	E
	21	27N	9W	21NW	N Fk Dupuyer	7500	N
	21	27N	9W	21NW	N Fk Dupuyer	7500	E
September	11	25N	9W	7SW	Frenchy Gulch	6600	SE
	11	25N	9W	12	Frenchy Gulch	7400	NE
	26	26N	9W	10	Blackleaf Cr	7000	E
	26	26N	9W	10	Blackleaf Cr	7500	E
	26	26N	9W	10	Blackleaf Cr	7000	E

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Appendix 45. Average percent frequency and cover of general vegetation classes from five mountain goat feeding sites analyzed each month from March through September, 1981.

	March	April	May	June	July	August	September
Bare Ground	6.6/0.3[1/]	14.9/1.0	54.7/7.8	70.7/11.6	58.7/9.5	34.7/4.5	54.7/9.3
Grass	60.0/1.8	60.0/7.2	77.3/14.8	84.0/16.3	89.3/13.7	61.3/3.6	88.0/15.8
Forbs	56.0/2.9	91.7/3.8	97.3/7.3	100.0/21.2	100.0/35.7	100.0/32.0	98.7/39.1
Shrubs	37.3/7.8	80.0/30.6	78.7/27.3	60.0/16.2	13.3/3.4	16.0/3.7	26.7/6.7
Rock	97.3/54.4	60.0/19.8	68.0/16.1	82.7/22.9	65.3/17.4	94.7/37.2	70.6/22.9
Sedge	17.3/0.4	23.3/3.3	20.0/0.6	16.0/1.1	18.6/1.0	49.3/5.6	29.3/4.4
Lichen	4.0/Tr[2/]	1.7/Tr	13.3/0.1	2.7/Tr	6.7/Tr	8.0/0.2	6.6/0.4
Litter	45.3/13.2	70.0/11.2	70.0/9.3	52.0/6.1	64.0/6.8	77.3/19.0	97.3/29.9
Moss (Snow)		30.0/1.4	30.6/1.0	10.7/1.8	24.0/3.5	28.0/0.8	14.6/3.5

1/ Frequency (occurrence in 15-2x5 dm frames)/average cover (average of cover categories in 15 frames).

2/ Tr = trace, less than 0.1 percent.

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Appendix 46. Average percent frequency and cover of plant species from five mountain goat feeding sites measured each month from March through September, 1981.

Trees	March	April	May	June	July	August	September
Abies lasiocarpa	X[1]				6.6/1.0[2]	5.3/0.7	X
Picea							X
*[3] - Pinus albicaulis		1.7/Tr[4]	1.3/Tr	X	X	X	
* Pinus flexilus	6.6/1.1	3.3/1.1	2.6/0.9	4.0/0.3	X	2.6/0.2	1.3/0.2
Pseudotsuga menziesii	1.3/Tr	X	4.0/0.2	1.3/0.5			X
Shrubs							
* Acer glabrum		3.3/Tr		1.3/0.8			1.3/Tr
Amelanchier alnifolia			5.3/Tr	8.2/0.5			X
* Arctostaphylos uva-ursi	26.6/3.8	36.7/13.8	46.7/20.1	9.3/3.9	8.0/2.3	X	1.3/0.5
* Berberis repens		28.3/0.2	4.0/Tr	2.7/Tr			2.6/0.4
* Juniperus communis	6.6/2.5	10.0/4.3	1.3/0.5	12.0/3.3	1.3/0.8	4.0/2.1	
* J. horizontalis		10.0/2.0	4.0/0.5				
J. scopulorum		1.7/0.2					
Lonicera utahensis					1.3/Tr		
Penstemon fruticosus				6.7/Tr			
Philadelphus lewisii		1.7/Tr					8.0/2.8
Potentilla fruticosa	14.6/2.6	25.0/2.7	8.0/3.3	9.3/3.0	5.3/Tr	9.3/0.6	8.0/1.5
Prunus virginiana		1.7/Tr	2.7/Tr	5.3/0.5			
Ribes sp.				X	X	1.3/Tr	
* Rosa sp.		30.0/0.2	45.3/0.2	40.0/1.4	4.0/0.2		
Rubus idaeus							4.0/0.7
R. parviflorus					1.3/Tr		
* Salix sp.						X	
S. artica		1.7/Tr	4.0/Tr				
* Shepherdia canadensis	1.3/Tr	20.0/5.1	6.7/2.2	2.6/0.7		2.7/0.7	5.3/0.8
Spiraea betulifolia					5.3/0.1		
Symphoricarpos albus				2.7/Tr			X
Forbs							
Achillia millefolium	1.3/Tr	18.3/Tr	18.6/Tr	29.3/0.4	66.7/2.6	30.7/1.3	49.3/3.5
Agoseris sp.			8.0/Tr	9.3/0.5	4.0/Tr		
* A. glauca				1.3/Tr	9.3/0.4	13.3/0.7	8.0/1.1
Androsace sp.	1.3/Tr						
A. lehmanniana	25.3/0.1			X	16.0/1.0	37.3/1.2	21.3/1.6
A. septentrionalis				X	24.0/0.2		

Appendix 46 continued.

Forbs continued	March	April	May	June	July	August	September
Angelica sp.							2.3/0.4
* Anemone multifida		8.3/Tr	17.3/0.2	5.3/0.6	5.3/0.4		13.3/0.8
A. nuttalliana		1.7/Tr		X			
* A. parviflora					33.3/3.5	17.3/1.4	1.3/Tr
Antennaria sp.	1.3/Tr		18.7/1.2	2.7/Tr	5.3/0.5		6.7/0.2
A. alpina		3.3/0.6	4.0/Tr	17.3/2.6	6.7/0.1	6.7/0.3	21.3/2.1
A. microphylla	1.3/Tr						
A. racemosa					9.3/1.4	4.0/Tr	
* Aquilegia flavescens					6.7/0.5	1.3/Tr	
A. jonesii						1.3/Tr	
Arabis sp.			1.3/Tr	8.0/Tr	6.6/Tr	2.7/Tr	
A. nuttallii	1.3/Tr		4.0/Tr				
Arenaria sp.			8.0/0.1		32.0/2.22	X	8.0/0.8
A. capillaris				4.0/Tr	6.7/0.3	5.3/0.1	
A. congesta				17.3/0.5			
A hookeri			6.7/Tr	1.3/Tr			
A. obtusiloba						2.6/0.2	5.3/0.6
* A. rossii						10.7/0.9	
A. rubella	6.6/Tr						
* Arnica sp.					5.3/0.3		
A. alpina							2.6/Tr
* A. cordifolia			2.7/Tr	1.3/Tr	12.0/0.6	8.0/1.3	2.6/0.2
A. latifolia					4.0/0.3		
A. longifolia							1.3/0.5
A. rydbergii					2.7/Tr		
* Artemesia michauxiana							10.7/1.6
Aster sp							1.3/Tr
* A. alpigenus						6.7/0.5	
* A. foliaceus				1.3/Tr	6.7/0.5	6.7/0.6	2.6/0.4
* A. integrifolius					2.7/0.2		
* A. occidentalis						12.0/1.3	
A. sibericus					1.3/Tr		
Astragalus sp.		X	1.3/Tr		10.7/1.0	14.7/3.1	37.3/5.4
A. alpinus					18.7/0.5		
* A. bourgovii			1.3/Tr	4.0/Tr	44.0/5.4	26.7/2.0	
A. miser			X				
A. vexilliflexus				8.0/0.2			
Balsamorhiza sagittata				1.3/Tr			

Appendix 46 continued.

Forbs continued	March	April	May	June	July	August	September
Besseya wyomingensis			5.3/Tr	9.3/Tr	2.6/Tr		
Boraginaceae					X		
* Bupleurum americanum		13.3/Tr	16.0/0.2	2.6/Tr	2.6/Tr	6.7/Tr	10.7/0.6
Campanula rotundifolia						10.3/0.1	8.0/0.2
Castilleja sp.				18.7/0.4	2.6/0.4	2.6/0.4	2.3/0.2
* C. rhexifolia					1.3/0.2	2.6/0.2	6.7/0.8
Cerastium arvense			1.3/Tr	13.3/0.2	2.6/Tr		10.7/0.9
C. berringianum			4.0/Tr			12.0/0.6	10.6/0.7
C. vulgatum				17.3/0.2	4.0/Tr		
Cirsium sp.	1.3/Tr				13.3/1.8	5.3/Tr	18.7/2.3
Claytonia megarhiza							X
Clematis sp.		X		X	1.3/Tr		4.0/0.3
C. pseudoalpina				1.3/Tr			
Collinsia parviflora	X			28.0/0.2	18.7/0.7		
* Comandra umbellata			1.3/Tr	2.6/Tr			
Compositae	2.6/Tr	8.3/Tr	6.7/Tr	14.7/1.0	5.3/0.1		5.3/0.6
Cruciferae			1.3/Tr	X	10.7/Tr	1.3/Tr	5.3/Tr
Douglasia montana	1.3/Tr	1.7/Tr	10.7/0.3		5.3/0.6		
Draba lonchocarpa		1.7/Tr		X			
D. oligosperma		5.0/Tr	1.3/Tr	1.3/Tr			1.3/0.2
D. paysonii					1.3/Tr		
Dryas octopetala	2.6/Tr				4.0/1.7	42.7/13.8	14.7/7.1
Epilobium alpinum				1.3/Tr			
* E. angustifolium			5.3/Tr	2.6/Tr	8.0/0.4		4.0/0.3
* Erigeron sp.					2.6/Tr		2.7/0.4
E. compositus	12.0/2.7	13.3/Tr	5.3/Tr	4.0/Tr		2.6/Tr	1.3/Tr
E. grandiflorus						1.3/Tr	
* E. humilus				5.3/Tr			
E. lanatus						16.0/2.2	
E. peregrinus							10.7/0.8
E. pumilus		5.0/Tr	8.0/Tr	2.6/0.2			
E. simplex					6.7/Tr		
E. speciosus					X	X	
* Eriogonum sp.		3.3/0.3	9.3/0.1	10.6/0.7			X
E. flavum					1.3/0.2	1.3/Tr	
E. ovalifolium	8.0/Tr			1.3/Tr	2.6/Tr	4.0/0.2	
* E. umbellatum				4.0/Tr	X		2.7/0.2
Erythronium grandiflorum		1.7/Tr		1.3/Tr			

Appendix 46 continued.

Forbs continued	March	April	May	June	July	August	September
* Fragaria virginiana		20.0/0.2	10.6/0.1	9.3/0.2	16.0/1.4	4.0/0.1	24.0/2.9
Frasera speciosa						1.3/0.2	12.0/2.1
* Gaillardia aristata				2.6/Tr	8.0/0.7	5.3/0.4	
Galium boreale	4.0/Tr	43.3/0.2	17.3/0.1	18.6/1.0	22.7/1.4	22.7/1.2	49.3/4.9
G. trifidum							1.3/0.2
G. triflorum			6.7/0.8	1.3/0.2			8.0/0.5
* Gentiana calycosa					6.7/0.4	6.7/1.1	
Geranium viscosissimum				X	X		
Geum sp.							5.3/0.1
Hackelia floribunda							X
* Haplopappus sp.				X			
H. lyallii					12.0/1.0	4.0/0.4	
* Hedysarum sp.				4.0/Tr		24.0/2.2	
H. alpinum					2.6/Tr		
H. sulphurescens					2.6/0.4		
Heracleum lanatum					1.3/0.2		5.3/0.6
Heuchera sp.	1.3/Tr	1.7/Tr	6.7/0.4	9.3/0.2			X
H. parvifolia	2.7/0.2						1.3/Tr
* Hieraceum sp.					1.3/0.2		
H. cynoglossoides				5.3/0.4			
Hydrophyllum capitatum				12.0/0.2	1.3/Tr		
Leguminosae						4.0/0.4	
Linum perenne				2.6/Tr			1.3/0.2
Lithospermum ruderale			X	1.3/0.2	2.7/6.6		
Lloydia serotina			1.3/Tr	1.3/0.2		14.7/0.2	5.3/Tr
Lomatium cous				8.0/0.1			
* L. dissectum			2.7/Tr	X			
L. triternatum		1.7/Tr		1.3/Tr			
Lupinus sp.			20.0/0.3	10.7/0.7	14.7/2.9		10.7/1.1
Mertensia oblongifolia					2.6/0.2		
Mitella breweri					X		1.3/0.2
Monarda fistulosa		1.7/Tr	6.7/Tr	8.0/0.7		2.6/Tr	
Myosotis sylvatica					4.0/0.1		
Osmorhiza occidentalis				1.3/Tr			
Oxytropis besseyi						16.0/0.5	
* O. sericea				2.6/Tr			8.0/0.7
Parnassia fimbriata					1.3/Tr		

Appendix 46 continued.

Forbs continued	March	April	May	June	July	August	September
Pedicularis sp.	X						
P. bracteosa	5.3/1.1				X		
* P. contorta			5.3/Tr	1.3/Tr	8.0/0.8	2.6/0.2	2.6/0.2
P. racemosa					1.3/0.2		
* Penstemon sp.	4.0/Tr	10.0/0.3	1.3/Tr	6.7/0.5	2.6/0.2	9.3/1.4	14.7/1.3
P. attenuatus		10.0/0.2		4.0/Tr			
P. confertus				2.6/0.4	2.6/0.2		
P. ellipticus	X				2.6/Tr		
P. eriantherus				X			
P. nitidus				2.6/Tr			
P. procerus				12.0/14.6		1.3/0.5	
Phacelia hastata				8.0/0.1	1.3/Tr	X	4.0/0.3
P. lyallii					X		
Phlox albomarginata						1.3/Tr	
Physaria didymocarpa				X			
Polemonium pulcherrimum					2.6/0.4		
Polygonum bistortoides						16.0/0.2	
Potentilla sp.							6.7/0.7
P. arguta		1.7/Tr		1.3/0.2			2.7/0.4
P. diversifolia				1.3/Tr	8.0/0.2	4.0/Tr	
P. gracilis	1.3/Tr		5.3/Tr	5.3/Tr		4.0/0.2	4.0/0.4
P. ovina			1.3/Tr	X	9.3/0.2		4.0/0.2
P. uniflora	X						
* Ranunculus eschscholtzii					44.0/3.2	6.7/0.6	
R. glaberrimus					5.3/0.1		
* Saussurea densa						X	
Saxifraga sp.			5.3/Tr				
S. bronchialis	1.3/Tr			1.3/Tr	4.0/0.4	16.0/1.6	16.0/1.7
S. oppositifolia	1.3/Tr					8.0/0.1	
S. rhomboidea	1.3/Tr		1.3/Tr		6.7/0.1		
Sedum lanceolatum	5.3/Tr	13.3/Tr	48.0/0.3	49.3/1.3	38.6/0.7	14.7/0.3	13.3/0.3
S. roseum	2.7/Tr						
Senecio sp.				2.6/Tr			4.0/0.4
S. canus		18.3/0.2	6.7/Tr		1.3/0.2	1.3/0.2	2.6/Tr
S. integerrimus				2.6/Tr		1.3/0.2	
* S. megacephalus					1.3/Tr		1.3/0.2
S. pauperculus							5.3/0.8
S. resedifolius					8.0/0.3	1.3/Tr	

Appendix 46 continued.

Forbs continued	March	April	May	June	July	August	September
Sibbaldia procumbens		3.3/Tr					
* Silene sp.					2.6/0.5		
Smelowskia calycina	2.7/Tr				X	6.7/0.5	
* Smilacena racemosa				12.0/0.8			
Solidago sp.						8.0/0.7	
* S. multiradiata			16.0/0.1	16.0/0.4	21.3/2.8	18.6/2.0	34.7/3.4
* S. spathulata							9.3/1.2
Taraxacum officinale		1.7/Tr	2.7/Tr	2.6/Tr	5.3/0.3	1.3/Tr	9.3/0.4
Thalictrum occidentale			1.3/Tr	X	6.7/0.4	1.3/Tr	2.6/Tr
Townsendia parryi				4.0/Tr		4.0/Tr	1.3/0.2
* Valeriana sitchensis				1.3/Tr	6.7/0.2	X	
Veratrum viride					1.3/0.5		
* Veronica cusickii					18.7/0.4		
* Viola sp.		3.3/Tr	1.3/Tr				
* V. adunca				4.0/Tr		2.6/Tr	5.3/0.2
V. orbiculata				2.6/Tr		2.6/Tr	
Woodsia sp.						X	
Zygadenus sp.			2.6/Tr				
Unknown forbs	1.3/Tr		8.0/Tr	20.0/0.3	20.0/3.1	1.3/0.2	1.3/Tr
Grasses							
* Agropyron sp.		X	1.3/Tr				22.6/1.6
A. caninum						9.3/0.2	
* A. spicatum		36.7/2.2	12.0/Tr	6.7/0.1			8.0/0.9
* A. trachycaulum					4.0/0.7		
* Bromus sp.				1.3/Tr	9.3/0.5	8.0/0.2	13.3/1.2
B. carinatus					8.0/0.2	X	
B. ciliatus						6.7/0.3	
B. inermis							6.7/0.7
* Calamagrostis purpurascens	1.3/Tr					2.6/0.4	2.6/0.2
* Carex sp.	X	23.3/3.2	17.3/0.5	12.0/1.3	9.3/0.3	18.7/1.7	
C. rupestris	29.3/0.5						
Danthonia sp.							1.3/Tr
D. intermedia			18.7/0.7	1.3/Tr			1.2/1.3
* Festuca idahoensis				5.3/0.6	12.0/2.1		10.7/1.1
* F. ovina	29.3/1.3	28.3/1.1	5.3/Tr	38.7/2.6	18.7/2.4	4.0/Tr	42.7/5.7
* F. scabrella	1.3/Tr	X	20.0/4.3	48.0/7.9	4.0/0.3		

Appendix 46 continued.

Grasses continued	March	April	May	June	July	August	September
* Koeleria cristata					2.6/Tr		
Luzula sp.					X		
Phleum alpinum					2.6/Tr		5.3/0.3
Poaceae	5.3/Tr						
* Poa sp.	X	6.7/Tr	26.7/0.4		50.6/3.1	2.6/Tr	X
* P. alpina					13.3/0.6	13.3/0.4	9.3/0.9
* P. cusickii			12.0/Tr	4.0/Tr	6.7/Tr	1.3/Tr	
* P. fendleriana				1.3/Tr			
* P. interior						2.6/0.2	12.0/0.8
* P. sandbergii			22.7/4.1			14.7/0.7	
Sitanion hystrix						1.3/Tr	
Stipa occidentalis							1.3/0.2
Trisetum sp.			1.3/Tr		1.3/Tr		6.7/0.4
T. spicatum	2.6/Tr				1.3/0.2	21.3/0.5	6.7/0.2
Unknown				1.3/Tr			
Unknown grass	4.0/Tr			13.3/0.1	25.3/0.9		1.3/0.2

1/ X = Occurred on the site but not in sample frames.
2/ Frequency (occurrence in 15-2X5 dm frames)/average cover (average of cover categories in 15 frames). Given in percent.
3/ * Plant had been grazed upon.
4/ Tr + Trace. Less than 0.1 percent.

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Appendix 47. Plant species known to have been fed upon at mountain goat feeding sites.

	March	April	May	June	July	Aug	Sept
Trees							
Pinus albicaulis		X					
Pinus flexilis	X						
Shrubs							
Acer glabrum		X					
Arctostaphylos uva-ursi	X	X					
Berberis repens		X					
Juniperus communis	X						
J. horizontalis		X					
Rosa sp.		X					
Salix sp.			X				
Shepherdia canadensis	X	X					
Forbs							
Agoseris glauca				X	X	X	X
Anemone multifida							
A. parviflora						X	
Antennaria racemosa					X		
A. umbrinella					X		
Arnica sp.					X		
A. cordifolia						X	
Artemesia michauxiana							X
Aster alpigenus						X	
A. foliaceus				X		X	X
A. integrifolius					X		
A. occidentalis						X	
Astragalus bourgovii				X			
Bupleurum americanum			X				
Castellija sp.					X	X	
Castellija rhexifolia						X	X
Cerastium vulgatum						X	
Commandra umbellata				X			
Compositae				X			
Epilobium angustifolium					X		
Erigeron sp.							X
E. humilus				X			
E. pumilus			X				
Eriogonum sp.				X			
E. umbellatum							X
Fragaria virginiana				X			
Gaillardia aristata						X	
Gentiana calycosa					X	X	
Haplopappus sp.				X			
Hedysarum sp.						X	
H. sulphurescens					X		
Hieracium sp.					X		
Lomatium cous				X			
Oxytropis sericea				X			
Pedicularis contorta					X	X	X

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Appendix 47 continued.

	March	April	May	June	July	Aug	Sept
Forbs continued							
Penstemon sp.	X						
Phacelia hastata						X	
Potentilla arguta				X			
Ranunculus eschscholtzii					X		
Saussurea densa						X	
Senecio megacephalus							X
Silene sp.					X		
Smilacena racemosa				X			
Solidago multiradiata						X	
S. spathulata							X
Townsendia parryi				X			
Valeriana sitchensis					X		
Veronica cusickii					X		
Viola sp.			X				
Unknown				X			
Grasses							
Agropyron sp.							X
A. spicatum		X		X			X
A. trachycaulum					X		
Bromus sp.						X	
B. ciliatus						X	
Calamagrostis purpurascens						X	
Festuca idahoensis				X	X		X
F. ovina				X			
F. scabrella	X			X	X		
Koeleria cristata					X		
Poa sp.			X				
P. alpina					X		
P. cusickii				X			
P. interior						X	X
P. sandbergii			X			X	
Trisetum sp.							X
T. spicatum						X	
Unknown				X			X

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Appendix 48. Plant genera which occurred in monthly mountain goat fecal samples.

	March	April	May	June	July	Aug	Sept
Trees							
Abies	X					X	
Pinus	X	X	X	X	X	X	X
Populus	X	X					
Pseudotsuga	X	X	X		X		
Shrubs							
Berberis	X	X	X				
Juniperus	X	X	X	X	X	X	X
Potentilla			X			X	
Prunus		X					
Ribes		X	X		X		
Salix	X	X	X	X	X	X	X
Shepherdia	X	X	X	X	X	X	X
Unknown	X	X	X	X	X	X	X
Grasses							
Agropyron	X	X	X	X	X	X	X
Agrostis	X	X		X			X
Bromus	X	X	X	X	X	X	X
Calamagrostis			X	X		X	X
Carex	X	X	X	X	X	X	X
Danthonia				X			
Deschampsia					X	X	
Festuca	X	X	X	X	X	X	X
Phleum		X	X	X	X	X	X
Poa	X	X	X	X	X	X	X
Stipa				X	X	X	
Trisetum	X		X	X	X	X	X
Unknown	X	X	X	X	X	X	X
Forbs							
Achillea		X					
Androsace	X	X	X	X	X	X	X
Antennaria	X	X	X	X		X	X
Arenaria	X	X	X	X	X	X	X
Astragalus	X				X	X	X
Besseya						X	
Cruciferae	X				X		X
Douglasia	X	X	X	X	X	X	X
Dryas				X	X	X	X
Erigeron	X		X	X	X		X
Eriogonum	X		X			X	
Galium						X	X
Hedysarum					X	X	X
Hieracium					X	X	X
Lomatium					X		
Lupinus				X	X	X	X
Penstemon		X					X
Phacelia				X	X		

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Appendix 48 continued.

	March	April	May	June	July	Aug	Sept
Forbs							
Phlox	X					X	X
Potentilla			X	X	X	X	X
Saxifraga		X	X				
Trifolium						X	X
Vicia					X	X	
Unknown	X	X	X	X	X	X	X
Unknown							
Root		X	X				

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Appendix 49. Relative percent occurrence of the top 10 plant genera in monthly mountain goat fecal samples.

	March	April	May	June	July	August	September
1.	Festuca 17.2	Festuca 15.6	Festuca 12.8	Festuca 22.2	Shepherdia 15.2	Astragalus 14.8	Shepherdia 14.6
2.	Juniperus 11.6	Berberis 13.8	Berberis 12.4	Poa 11.8	Astragalus 14.0	Androsace 9.4	Poa 9.2
3.	Pinus 10.2	Juniperus 13.2	Shepherdia 11.6	Shepherdia 9.6	Carex 6.8	Poa 8.2	Carex 8.4
4.	Arenaria 8.8	Poa 6.8	Juniperus 8.4	Agropyron 7.8	Arenaria 6.8	Carex 7.4	Astragalus 7.6
5.	Pseudotsuga 8.2	Carex 6.4	Poa 6.8	Androsace 7.0	Unk. Forb. 6.8	Festuca 7.4	Androsace 5.8
6.	Carex 6.6	Unk. Grass 5.0	Agropyron 6.4	Uncl. Grass 5.6	Potentilla 6.0	Arenaria 5.8	Unk. Forb 5.0
7.	Androsace 5.8	Shepherdia 4.8	Pinus 6.2	Carex 4.4	Lupinus 5.2	Unk. Forb 5.6	Arenaria 4.8
8.	Unk. Grass 4.8	Androsace 4.2	Unk. Browse 4.2	Arenaria 3.6	Poa 4.8	Douglasia 5.4	Pinus 4.6
9.	Unk. Browse 4.0	Arenaria 3.4	Phleum 3.8	Douglasia 3.6	Douglasia 4.6	Bromus 3.6	Unk. Grass 4.6
10.	Unk. Forb 4.0	Unk. Forb 3.4	Unk. Grass 3.6	Lupinus 3.2	Festuca 4.0	Shepherdia 3.4	Bromus 4.2

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Appendix 50. Annotated bibligraphy of relationship between human developments and wildlife with special emphasis on mountain goats.

Boyle, S.A. and F.B. Samson. 1985. Effects of non-consumptive recreation on wildlife: A Review. Wildl. Soc. Bull. 13:110-116.

The effects of non-consumptive outdoor recreation were summarized in a review of 536 references, addressing birds, mammals, and herpetofauna of North America. Negative effects were reported most commonly for most activity types and all major taxa; reports of positive effects are few. Recreationists can affect wildlife through habitat alteration, disturbance, or direct mortality. Mechanized forms of recreation present the most serious potential impacts, but even the most casual intrusion by a person on foot may significantly affect vulnerable populations. Individuals, populations, and species vary in their sensitivity to disturbance and researchers have begun to identify some mechanisms of human wildlife interactions. Wildlife conservationists are challenged to identify recreational impacts on wildlife, establish priorities for management, and implement schemes to conserve wildlife resources while providing for increase use-demands of recreationists.

* *

Bromley, M. 1985. Wildlife management implications of petroleum exploration and development in wildland environments. USDA Forest Service, Intermountain Research Station, Ogden, UT. General Technical Rpt. INT-191. 42 p.

This report describes the sequence of events, their characteristics, and the associated environmental disruptions involved in the exploration, development, and production of petroleum. The potential effects of environmental disruptions on wildlife behavior, populations, and habitat are evaluated, drawing on a review of the literature, supported by a selective, annotated bibliography. Potential effects are numerous and varied. Impact severity is site specific and depends on the sensitivity of the species affected, the nature of the environmental disruption, habitat characteristics, and the availability and condition of alternative habitat. The major wildlife groups affected by petroleum activities are ungulates, carnivores, water birds, upland birds, and raptors. Possible approaches to minimizing adverse effects on wildlife are presented including changes in management of petroleum projects, personnel, and wildlife habitat and populations.

* *

Edwards, W.C. DVM. 1985. Oil field wastes create numerous hazards for livestock. Veterinary Medicine, April:98-104.

In oil producing states, the proximity of livestock to oil exploration and production sites often results in poisoning of animals from ingestion of crude oil, condensate, salt water, caustic chemicals, and heavy metals. In 1982, there were 587,472 oil wells in the U.S. producing an average of 14 barrels per well per day. The average drilling site will use 3-5 acres of land. Approximately 500 cases of suspected poisoning due to oil field wastes are investigated at the Oklahoma Animal Disease Diagnostic Laboratory each year. Most cases present the potential for litigation. Cases in which livestock are exposed to oil, salt water, or caustic chemicals but do not die acutely are more frustrating to diagnose. Affected animals become unthrifty and lose weight. In these cases parasitism, poor nutrition and other debilitating diseases must be considered. Chemicals may alter the animal's rumen flora and enzymatic actions that caused impaired digestion of carbohydrates, synthesis of B vitamins, and conversion of cellulose to volatile fatty acids. The direct physical hazards to livestock and wildlife are minimal in most exploratory operations. Several pounds of pipe-joint or thread compound are used, which contain up to 40% lead-powder base. The vast amount of salt water associated with oil production is a major cause of environmental damage and livestock injury. Some companies treat petroleum on site with xylene and other solvents to dissolve paraffin. Arsenical soil sterilants to control weeds have poisoned cattle. Breaks in pipelines may not be discovered and repaired in remote sites until several thousand gallons of oil have been lost. Animals in Oklahoma ingest salt water more often during winter when fresh water sources may be frozen. Diagnostic labs can assist in diagnosing cases of suspected poisoning from oil field wastes if proper specimens are submitted for analysis.

* *

Foster, B.R. 1982. Observability and habitat characteristics of the mountain goat (Oreamnos americanus Blainville, 1816) in west-central British Columbia. M.S. Thesis. Univ. of B.C.

Forty-five percent of the world's mountain goat population occurs in B.C. Increasing vehicular access has created conflicts and hunting pressure which threaten their survival. This research studies the spatial and temporal patterns of habitat use by mountain goats within a densely populated region of west-central B.C. A number of conclusions about the effectiveness of animal inventory techniques were made. It is recommended that development of new, standardized techniques be a priority issue. Management guidelines and harvest strategies should not be implemented without the ability to monitor their effect.

* *

Foster, B.R. and E.Y. Rahs. 1983. Mountain goat response to hydroelectric exploration in Northwestern British Columbia. Environmental Management 7(2):189-197.

The behavioral response of more than 800 mountain goats were recorded during hydroelectric exploration activities (primarily aircraft). Four categories of overt responses were recorded, ranging from maintenance activity to severe flight. More than 80% of the observed goats elicited some form of behavioral stress response, with 33% displaying a severe flight response. Responses were stimulated primarily by auditory and secondarily by visual cues. Temporary range abandonment and changing observability indicies were documented.

* *

Foster, B.R. and E.Y. Rahs. 1985. A study of canyon-dwelling mountain goats in relation to proposed hydroelectric development in Northwest British Columbia, Canada. Biological Conservation 33:209-228.

Preliminary ecological relationships between a resident mountain goat population and a proposed hydroelectric development were investigated in 1979 and 1980 along the Stikine River, in northwest B.C. Population size was estimated at 316 along 5.4 km of canyon. Localized goat mortality and possible temporary range abandonment observed in the proposed Site Z dam area may have resulted from 1978 and 1979 hydro exploration activities. Proposed construction activities could similarly affect up to 56 goats. Major mitigation measures involve design and control of land and aerial access, and reduction of noise and related disturbances during critical biological periods. Possible compensation measures include range enhancement, establishment of goats in vacant habitat, and development of viewing facilities. Some goats were observed to respond to human disturbances at distances greater than 1600 m. Goats react more strongly to aircraft than do most other ungulates (Shank 1979). Calef et al. (1976) and Miller and Gunn (1980) indicate that flights over northern ungulates should be 300 m or more in height in order to significantly reduce or eliminate fleeing responses. This paper recommends flights be restricted to at least 600 m above ground level.

* *

Fox, J.L. 1983. Constraints on winter habitat selection by the mountain goat (Oreamnos americanus) in Alaska. PhD. Dissert. Univ. of Washington. 147 p.

Habitat selection by mountain goats during winter is potentially constrained by requirements for predator avoidance, food acquisition, and thermoregulation. Pellet group data indicates that goats use slopes equal to or greater than 35 degrees more than those less than 35 degrees when away from escape terrain.

Slope steepness during winter ranges 35-50 degrees. Most goat use is within 200-300 m of escape terrain during winter. McFetridge (1977) indicates that during summer 95% of goat use is within 600 m of escape terrain. Habitat was not selected for thermoregulation unless conditions were less than -10 C and windy. Thermal benefits of moving to lower and warmer elevations did not outweigh other benefits of remaining. Thermoregulatory behavior will create selective pressure only during most severe weather conditions. Predator avoidance and food are both essential and consistent daily determinants of habitat selection. Predator avoidance tends to have greater weight in that it explains most habitat use. The amount of time spent feeding is not necessarily an indication of the amount of food procured, since intake rate is probably highly correlated with forage abundance. In the region outside of steep, broken terrain, food acquisition appears to be a major determinant of habitat selection. In coastal ranges, heavily forested areas provide important winter goat habitat. Without the range from alpine to low elevation forested areas, goat survival is limited in coastal areas. Interior ranges are colder, and lower elevation accumulate snowpack, so it is to the goats advantage to stay high were winds remove snow. Also, drier snow filters through timber so forage in timber in interior habitats tends to be buried. Logging: Forested areas more than 500 m from steep broken terrain are probably essentially unused or used primarily for travel if they are between wintering sites. Direct effect on these sites over 500 m are basically restricted to factors which may change energy expenditures for travel between wintering sites: slash and increased snow depth. Though more forage may grow in cut areas, it is unavailable due to increased snow depth. For a substantial period after canopy closure, potential understory forage is greatly diminished, thus keeping the logged site less attractive than "old growth" forest for foraging.

* *

Geist, V. 1975. Harassment of large mammals and birds, with a critique of the research submitted by Arctic Gas Study Ltd. on this subject. Report to the Berger Commission. Faculty of Environmental design, Univ. of Calgary, Alberta.

This paper, through an extensive literature review, describes what constitutes harassment; the effects of harassment--physiological responses produced by it, and variable behavioral responses; the causes of harassment, and the importance of recognizing that different species may respond quite differently to the same stimulus as a matter of evolutionary adaptation. Harassing stimulus is described as, precipitating excitement - a physiological state which is not always readily detectable externally. Intense and frequent harassment which imposes a burden on the energy and nutrient supply of the animal can become the so called "alarm reaction" the first phase of stress (Selye 1950). Harassment, by greatly

elevating the metabolism of the body, elevates the cost of living to the animal at the expense of its body growth, development, and reproduction. The metabolic cost of excitation is highly variable, and can temporarily exceed twice the maintenance cost. A hard-running animal can exceed by 20 times, the cost of basal metabolism. Climbing costs about 12 times as much as locomotion on the level. The cost of harassment in terms of energy consumption depends therefore, on the intensity and duration of excitation, the distance and elevations covered by the escaping animal, and also the decrease in food intake it may incur as a consequence of harassment. Daily intake of energy by ruminants is very low, and costly activities can quickly put the animals into negative energy balance.

Animals respond to harassing stimuli by avoiding it, habituating to it, or becoming a victim of stress adaptation. The latter in particular, results in detrimental consequences to the animal; however those who attempt to avoid harassment may temporarily or permanently abandon a portion of their range, thus resulting in loss of resources, increasing susceptibility to predators, and ultimately reduced population. Habituation can occur in many, but not all animals, as long as there is time to explore these stimuli and they prove harmless. Relative to aircraft harassment of caribou, recommendations are presented suggesting defined flight corridors, restricted number of flights, and maintenance of a minimum flight height of at least 2,000 feet above ground.

* *

Gunn, A., F.L. Miller, R. Glaholt, and K. Jingfors. 1983. Behavioral responses of barren-ground caribou cows and calves to helicopters on the Beverly herd calving ground, Northwest Territories. Proceedings of the First North American Caribou Workshop.

Barren ground caribou cows and calves are readily displaced and their activity patterns interrupted by helicopter overpasses and landings at a distance of 300 - 2,200 m. Such helicopter activity led to disruption of on-going maintenance activities, and elicited behavioral responses that led to displacements of at least 1-3 km (before caribou were out of sight).

* *

Interagency Rocky Mountain Front Wildlife Monitoring/Evaluation Program. 1984. Management Guidelines for Selected Species, Rocky Mountain Front Studies. Lewis and Clark National Forest, Bureau of Land Management, U.S. Fish and Wildlife Service, Mont. Dept. of Fish, Wildlife and Parks. 63 p.

The need for management guidelines is predicated on management concerns involving the effects of existing and proposed land uses and human activities upon various wildlife species and their

habitat. The objective of the development and application of management guidelines is to avoid or minimize the following effects of human related activities which may adversely impact some or all of the selected wildlife species being considered: physical destruction of important wildlife habitat components; human disturbance that would displace various wildlife species from important seasonal use areas; increased direct human caused mortality; increased stress due to higher human activity levels; direct mortality or physical impairment resulting from environmental contaminates; increased wildlife/human interaction resulting from habitat intrusion or displacement. These guidelines specifically address grizzly bear, mountain goat, bighorn sheep, elk, mule deer, and raptors. Nineteen general management guidelines apply to all species, but the following are especially applicable to mountain goats: space concurrently active seismographic lines at least 9 air miles apart to allow an undisturbed corridor into which wildlife can move when displaced; establish helicopter flight patterns of not more than ½ mile in width along all seismographic lines; helicopters will maintain a minimum altitude of 600 feet above ground level when flying between landing zones and work areas where landing zones are not located on seismic lines; the use of helicopters instead of new road construction to accomplish energy exploration and development is encouraged; locate roads, drill sites, landing zones, etc. to avoid important wildlife habitat components based on a site specific evaluation.

Thirteen specific mountain goat guidelines are detailed. The seasonal use periods within designated occupied year-long habitat which should be avoided by human activities include: Kidding - nursery areas - May 1 - July 15; Breeding areas - November 1 - December 31; Winter range - October 15 - May 15.

* *

Irwin, L.L. and C. Gillin. 1985. Response of elk to seismograph exploration in the Bridger-Teton National Forest, Wyoming. Dept. of Zoology and Physiology, Univ. of Wyoming, Laramie. 53 p.

Responses of 15 radio-collared elk to actual and simulated seismic activity revealed various degrees of movements. Elk were consistently displaced by seismic activity averaging 3/4 mile. Elk tended to maintain a 3 mile distance from seismic activity. Elk moved progressively further from the line as various phases of the line progressed. Elk doubled their use of dense canopied timber during disturbances in spring. They used higher elevations after than before disturbance, stayed closer to cover, and used upper steeper slopes. Radio-marked elk were not displaced from their home range. Elk already using timber did not change habitat use. Seismic activity displaced elk from preferred alpine feeding areas for up to 2 weeks. Energy costs of rapid movements are critical even if elk are not displaced to

poor foraging habitats. No observed problems were manifest as a result of displacement to poor habitats; however, the elk in this study are not characteristic of elk in the Rocky Mountain as a whole in that they are fed a supplemental diet in winter, which would negate most forage deficiencies on summer range. Recommendations regarding seasonal timing of seismic lines, spacing and relative timing of multiple lines, flight corridors, heights, and landing zones, avoidance of concentration areas, location of lines in timber and the need for agency/industry cooperative workshops are discussed.

* *

Joslin, G. 1980. Mountain goat habitat management plan for the Cabinet Mountains. Montana Dept. of Fish, Wildlife and Parks in cooperation with Kootenai National Forest. 122 pp.

Written as an aid for habitat and wildlife managers who employ temporary and volunteer help on a seasonal basis within mountain goat habitat, this plan identifies human land-uses commonly confronting mountain goats, and it serves as a primer for the first-time acquaintance to mountain goat country. The mountain goat population within the Cabinet Mountains of northwestern Montana has declined from historic levels. Current seasonal distribution and population levels are identified. Road access, logging, hard rock mining, livestock grazing, fire, recreation, and mountain goat transplants within the Cabinets are discussed.

* *

Klein, D.R. 1973. The reaction of some northern mammals to aircraft disturbance. Pages 377-383 in XI International Congress of Game Biologists. Stockholm. National Swedish Environment Protection Board.

This Alaska study on caribou assessed animal response to aerial disturbance. The increasing use of low-flying fixed-wing aircraft and helicopters in remote areas occupied by ungulate populations has focused attention on the possible detrimental effects of aircraft disturbance on wildlife. Such disturbance is most important in treeless terrain, where animals are visible for long distances and escape cover is lacking. A study was initiated in arctic Alaska during 1973 to determine the specific reactions of caribou to controlled aircraft disturbances. Observations of flight distances and other behavior of the tested animals were recorded in relation to altitude and angle of approach of the aircraft, intensity and frequency of the sound generated, and the external factors, such as weather conditions and terrain characteristics.

In the Soviet Union, helicopters and fixed-wing aircraft were used increasingly in the herding of reindeer for a number of years, but this practice has been largely discontinued due to the detrimental effects experienced by the reindeer. In the publication on reindeer husbandry in the Soviet Union, edited by Zhigunov (1961), disturbances of reindeer from various causes are reported to be responsible for losses in body weight, weakening of animals and increased susceptibility to diseases, and particularly emphysema during very cold weather, abortion of embryos through loss of maternal body weight or injury while running, desertion or trampling of newborn fawns, and displacement of fetuses at calving time leading to difficulties during delivery.

* *

Kuck, L., G.L. Hompland, and E.H. Merrill. 1985. Elk calf response to simulated mine disturbance in southeast Idaho. J. Wildl. Manage. 49(3):751-757.

Calves were sensitive to human harassment and mine noises. Effects were greatest in response to direct human harassment, and noises also elicited strong response. Some cow/calf groups left the disturbance area. The most common solution to initial disturbance was to use topography to create a barrier. The tendency to return to the traditional use area was reduced after several disturbance trials. This is in keeping with Geist's philosophy that prolonged, frequent, unpredictable, human harassment could severly alter species behavior, with implications to physiology, population dynamics, and ecology. Elk and deer react to the approach of humans more than other disturbances. Calef and Lortie (1973) indicate that single disturbance sessions may be insignificant but the effects are cumulative and could result in reduced calf survival or increases in aborted fetuses. Serious consequences of persistent disturbance can be the voluntary withdrawal from available habitat and the use of smaller, less favorable areas. Calves may imprint on, and continue using marginal habitat through life. If animals are displaced from preferred sites where ambient temperatures are more favorable, young may suffer from hypothermia in cool wet springs when micro-climates can be very important during the first few days of life.

* *

MacArthur, R.A., V. Geist, and R.H. Johnston. 1982. Cardiac and behavioral response of mountain sheep to human disturbance. J. Wildl. Manage. 46(2):351-358.

Low reaction of sheep to human disturbance in Sheep River Wildlife Sanctuary west of Turner Valley Alberta was observed in a predictable environment where a road was the focal point of human activity. People with dogs, and people approaching from

over a ridge elicited the highest heart rate response. There are some indications that the steeper the slope, the lower the heart rate to stimuli, suggesting the importance of steep terrain in the habitat requirements of mountain sheep. "In agreement with behavioral studies of mountain sheep and other social ungulates (caribou and gazelle) our data also imply greater security (i.e. lower heart rate response to disturbance) with increased group size." The ability of mountain sheep to coexist with humans in areas protected from hunting is well known and this study reveals the extent to which this species is capable of habituating to common human-related stimuli. Though acceptable correlations often result, the regressions relating HR and MR (metabolic rate) may vary with individual animal, time, behavior, and social context. HR may not reflect MR accurately. HR usually was not longer in duration than the actual observed behavioral response. This might suggest that HR provides little additional information to that obtained by behavioral observation alone. But this study was of habituated sheep, so in wilder populations, HR would likely be greater than what behavior alone might indicate. HR provides a more objective means of quantifying response to harassment than behavioral cues alone. There are several reasons why HR is a good factor to use in evaluating response of animals to stimuli. One stimuli may sensitize an animal to another. All ground vehicles elicited similar low response. Over 400 m, helicopters or fixed-wing aircraft had no increased effect on HR but no HR responses were associated with helicopter or fixed-wing aircraft at distances exceeding 400 m from sheep. However, during 5 direct overflights by Bell-206 or Hughes-500 helicopters at 90-250 m above ground level, HR of 3 ewes increased 2-3.5 times with recovery times of 20-65 seconds. Survival and optimal use of habitat by individuals demand high levels of vigilance so that stimuli, indicating presence of predators, conspecifics, food or shelter do not go undetected. Yet if an animal is excessively aroused, as from human disturbance, the added cost of excitement may interfere with health, growth and reproductive fitness.

* *

McCallum, M.J. 1983. The feasibility of a reintroduction of mountain goats to Bullmoose Mountain, British Columbia. M.S. Thesis. Univ. of Calgary, Alberta. 154 pp.

Development of B.C. northeast coal block probably contributed to the mountain goat population decline. The population was at least 166 goats in the early 1960s and went to no goats by the end of the 1970s. Pendergast (1975) indicates that no attempt was made to minimize disturbance during coal exploration. The ability to control disturbance will likely determine whether or not reintroduced goats will survive on Bullmoose Mountain. Control of disturbance may be achieved through hunting

regulations, public education, access control, careful control of development projects, and aircraft flight ceiling restrictions. None of these controls alone would be adequate to control disturbance; they must all be fulfilled simultaneously. When the size of game management areas is reduced, herds can be more adequately managed. Population fluctuations are more apparent than in large management areas. Public education is important in avoiding non-consumptive demand impacts which, even in minor amounts, can be harmful, especially at critical times of year. The success of the goat reintroduction hinges to a large degree upon the effectiveness of access control and the associated public attitudes. Several authors recommended a flight ceiling of 600 m and a lateral flight restricted area of 2,000 m from goat habitat.

* *

Olson, G. 1983. Effects of seismic exploration on summering elk in the Two-Medicine-Badger Creek area, Northcentral Montana. Pages 23-42 in Malcom, J. (ed) Mitigating the impacts of mineral exploration and development on wildlife. Proc. of the 1983 Annual meeting of the Montana Chapter of the Wildlife Society. Missoula, MT

Four elk were monitored during spring, summer, and fall, 1981 to assess the effect of seismic exploration upon movements. Two elk occurred in the Middle Fork Flathead (wilderness) undisturbed control area. Average distances moved between flights of radio-marked elk in the disturbed area were 50% greater than marked elk in the undisturbed area. Elk preferred to remain at least 1 ridge or drainage from helicopter or blasting activity, mostly in heavy cover. An elk in Glacier National Park moved over a pass when seismic activity in the adjacent Two Medicine valley began. Levels of activity in winter similar to that of summer may cause severe physiological stress on the South Fork Two Medicine herd. Forced movements to marginal winter ranges may disrupt reproductive processes and nutritional balances. The net effect could be calf losses and death of weaker segments of the herd structure. Recommendations for future seismic activity include: (1) eliminate seismic activity on occupied winter range from November 1 to May 15, (2) prevent disturbances in known calving and spring migration zones from May 1 to July 1, (3) designate specific travel routes, no more than ½ mile wide, for aircraft and work crews to minimize "cut across" traffic between lines. Helicopters in flight should maintain a 500 foot elevation above valley bottoms, sideslopes, and passes. Bighorn sheep and mountain goat concentration areas should be avoided altogether, (4) maintain a distance of 1 main drainage or 3 tributary drainages between concurrent seismic lines. On perpendicular lines, a 5 mile spacing should be maintained at all times.

* *

Pendergast, B. and J. Bindernagle. 1977. The impact of exploration for coal on mountain goats in northeastern British Columbia. Pages 64-68 in Samuel, W. and W.G. MacGregor (eds) Proc. of the First International Mountain Goat Symposium. Kalispell, MT

Coal mining and related activities conflict with the maintenance of mountain goat populations. In northeast B.C. coal exploration has correlated with a decline of mountain goat populations. Depressed populations have shown no sign of recovery. Twenty percent of the mountain goat range is under license by coal companies. The precise mechanism of the decline is not known but appears to be related to easy human access. Habitat destruction is not an important factor in known losses, but may be a factor in attempts to reestablish populations after mining. New approaches to management may have to be developed for mountain goat populations with intact habitat but easy human access. High populations still exist in remote parts of the coal block, but present management techniques based on manipulation of open season length will not protect these populations if their habitat is explored for coal using road dependent equipment.

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Penner, D.F. 1984. Ecological and behavioral studies on mountain goats at Pinto Creek, Alberta. Part II: Behavioral disturbance studies. McCourt Management Ltd., Environmental Consultants, Edmonton, Alberta. 75 p.

A behavioral disturbance study was conducted on mountain goats at Pinto Creek to assess goat behavioral responses to natural and human-caused stimuli in conjunction with baseline ecological studies of mountain goats during March 1981 to July 1983. A program of introducing industrial-like acoustical stimuli was initiated in August, 1982 to condition goats to learn that such predictable, distant and indirect stimuli were harmless. This "habituation program" was begun as pre-development mitigation that would continue on a periodic basis and intensity until the proposed well-drilling operations began. Goat responses to environmental stimuli were recorded using an index of overt behavioral responses and monitoring of daily activity and habitat use patterns. The intensity of acoustical stimuli was gradually introduced during eight monthly sessions to achieve a maximum sound pressure level similar to the attentuation curves of a distant (0.5 to 1.0 km) operating drilling rig. Mountain goats exhibited tolerance of, and appeared to generally ignore or accept, the indirect and persistent acoustical stimuli. Greater behavioral responses were to sudden or initial acoustic stimuli, to new visual stimuli and direct interactions. The stimulation program was successful in increasing goat awareness of introduced

stimuli without causing a noticeable increase in concerned or alarmed responses. Goats also exhibited a tolerance of distant observer presence. Goats appeared more sensitive to environmental stimuli during kidding and post-kidding periods in spring and early summer than during other seasons. The seasonal distribution patterns of goats appeared unaffected by the experimental program. Biological meaningful changes in overt behavior, activity budgets and habitat use patterns by goats were not apparent in response to the experimental program.

* *

Penner, D.F. 1986. Habituation of mountain goats to auditory stimuli prior to a seismic program at Pinto Creek, Alberta. McCourt Management Ltd., prepared for Fish and Wildlife Div. Alberta Energy and Natural Resources. 49 p.

A program for the habituation of mountain goats to acoustic stimuli was conducted to mitigate the potential effects of behavioral disturbance on goats from a seismic program at Pinto Creek. The last session overlapped with 5 days when the seismic program activities were nearest to the goat herd on their traditional winter range. The goat herd consisted of nine animals in fall, 1984. The goats' typical behavioral response to initial observer presence or introduction of broadcast sound was curiosity. These responses were generally of short duration before the goats resumed maintenance activities. The goats appeared to exhibit an increasing acceptance or tolerance of persistent stimuli during each day and on subsequent days of the habituation sessions. A distinct decline in goat response levels to gunshots was recorded through the habituation program. Initially, gunshots elicited directional alertness by all goats. Intraspecific behavior during rutting activities in the first habituation session appeared to generally increase the alert attitude of adult goats. This may have been compounded by observer presence and introduction of acoustic stimuli. The goats appeared to tolerate the impinging noise and the observers presence with only periodic curious and occasional concerned responses. Normal maintenance activities appeared uninterrupted and the goats would engage in extended foraging bouts in the upland forest zones. The additional noise stimuli from seismic line clearing activities during the third session resulted in elevated alertness by goats on several days. The goats nervousness was indicated by prolonged period (up to two hours) of curious responses and frequent changes in directional alertness. The goats' behavioral attitude was interpreted as nearing a threshold of tolerance before they would abandon their habitat for other cliff units. Noise stimuli from several sources appeared to have a synergistic effect which elevated the goats' behavioral response levels. Except for the few periods of heighted alertness, the goats appeared to accommodate the impinging acoustic stimuli and did not alter their normal habitat use and daily activity patterns. The author felt that the

habituation program achieved its objective of increasing the mountain goats' tolerance to noise stimuli that were initially perceived as potentially threatening. The use of habituation as a pre-development mitigation measure is a positive approach for reducing potential impacts.

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Phelps, D.E., B. Jamieson, and R.A. Demarchi. 1975. Mountain goat management in the Kootenays. I. The history of goat management, II. A goat management plan, 1975-1985. Fish and Wildlife Branch, Court House, Cranbrook, B.C. 59 p. mimeo.

Mountain goat populations in the Kootenays suffered a severe decline during the 1960's. Data at that time was compiled on a management area basis. Until 1971, no downward trends in harvest, success, sex ratios or age class structure, indicative of over-harvest, were discernable, though based on a subjective knowledge of the situation, seasons were reduced and closures instituted from 1966 on, with the season finally being closed in 1971. In 1973 the hunter sample data was reworked and compiled by watershed. The pattern of harvest distribution that emerged indicated that over-exploitation of goat herds began as early as 1960 in some watersheds. The decline of goat harvest that resulted in these areas was masked by increasing harvests in other watersheds where new access made previously unhunted herds available. The continuous expansion of access through the 1960's allowed the maintenance of a high goat harvest by progressive exploitation and decimation of previously unhunted herds.

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Rice, L.A. and T.A. Benson. Rocky Mountain goat population status in the Black Hills, South Dakota, 1983-84. Dept. of Game, Fish and Parks, Pierre, SD. 46 p.

A recent mountain goat population decline in the Black Hills was documented with cause or causes of the decline unknown, but human recreational use of the area may be implicated. Tentative data from 9 radio-collared goats showed home range was established with avoidance of the wilderness area. Hiker use was suspected of causing this occurrence. Mountain goats avoided the 1 trail open to pedestrians in the Mount Rushmore National Monument which received over 10,000 people per day. Habitat use, population dynamics, and censusing techniques were addressed. Data results indicated any harvest in future years would have to be greatly restricted. Such harvest would have to emphasize an adult male harvest if possible. For restricted population growth to occur, no more than 5% harvest of the estimated population would be recommended.

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Ritchie, C. and G.S. Watts. 1984. Re-establishment of mountain goats on Bullmoose Mountain. A Habitat Conservation Fund Final Report. Ministry of Environment, Fort St. John, B.C. 7 p.

Twenty-three mountain goats were transplanted to Bullmoose Mountain by helicopter. A large population of mountain goats once occupied the mountain but the entire population was extirpated through a combination of hunting and industrial disturbance. A feasibility study concluded that the area could support up to 150 mountain goats. Tentatively, this appears to be a successful transplant in that the following objectives are being met: (1) to re-establish 29-30 mountain goats, (2) create a mountain goat population available for public viewing opportunities and non-consumptive use, (3) create harvestable population within 15 years (will require a minimum 10 year delay).

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Schultz, R.D. and J.A. Bailey. 1978. Responses of National Park elk to human activity. J. Wildl. Manage. 42(1):91-100.

Park elk during the rutting period and when they are concentrated on winter-spring ranges respond more vigorously to humans. Mammals learn to minimize encounters with humans if harassed enough, by reducing activities to areas, habitat, and times of day where encounters with humans are minimal. The damage was greatest when disturbance was frequent and unpredictable. Mean flight distances were longer when approached by a human on foot, than by vehicles. Elk were significantly more apt to trot from an approaching person than from a vehicle.

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Stemp, R.E. 1983. Heart rate responses of bighorn sheep to environmental factors and harassment. M.S. Thesis, Univ. of Calgary, Alberta. 314 p.

The response of 5 free-ranging bighorn sheep to their environment were evaluated via heart rate telemetry. Heart rate is a well-established correlate of anxiety and arousal, i.e. a good indicator of stress. Certain habitat features were important to the security of the sheep: heart rate increased exponentially with distance from cliffs, and was higher when the sheep were in unsecure habitat; when low on slopes, or when near a road. Good visibility and advantageous footing appeared to reduce anxiety. Security needs limited habitat use by sheep. The effects of intruders were evaluated by the length of time over which they caused significantly higher heart rates in sheep. This showed intruders could cause considerable stress. Withdrawal occurred in 60% of all approaches. Behavior was, however, a poor indicator of the stress response to intruders. Strategies are

recommended for the management of bighorns, notably preservation of habitat that meets both their security and physical needs, and control of human access to sheep ranges. The physiological effects of stress upon bighorns, especially the consequences for fetuses and newborns are discussed.

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Smith, C.A. and L. Nichols. 1984. Mountain goat transplants in Alaska: restocking depleted herds and mitigating mining impacts. Pages 467-480 in Hoefs, M. (ed) Northern Wild Sheep and Goat Council, Proceedings of the Forth Biennial Symposium. Whitehorse, Yukon.

Two mountain goat transplants in Alaska were documented. One (Kenai) was designed to replenish a population previously decimated by hunting and the other (Revillagigedo Island) to establish a new population on vacant range as a mitigation for anticipated losses in a nearby herd exposed to mineral development. Two males and 10 female mountain goats survived the Kenai transplant, but 2 females died immediately afterwards, and 2 additional females dispersed from the release site. Dispersing goats showed distinct "homing" directionality. Five male and 12 female goats survived the Island transplant and no mortalities were documented through March 1984. Lactating females appeared to search for their lost kids and 4 of these females dispersed from the release site in the Island transplant. Probable breeding of the remaining females was documented. Any transplanted goat is likely to be more mobile than its resident counterpart, and the dispersal of several females from the release sites in both areas indicates that it may be necessary to introduce more than the desired minimum number of goats to establish a population. The reasoned use of transplants after adequate habitat suitability studies are completed to restock depleted herds or establish new populations to mitigate impacts of development on native mountain goat populations is encouraged.

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Ward, A.L. and J.J. Cupal. 1979. Telemetered heart rate of three elk as affected by activity and human disturbance. Pages 47-56 in Shaw, J. (ed) Dispersed recreation and natural resources management: A Symposium. Utah State Univ.

Telemetry information from confined and free-roaming elk carrying implanted transmitters and neck collar repeaters, showed immediate and readily discernable responses in heart rate owing to activity and human disturbances. The heart rate telemetry system allows recording of both active and passive responses. Events such as humans on foot and gun shots produced high percentage of positive heart rate reactions, particularly if the disturbances were within 300 m of the elk. These encounters

likewise resulted in a high percentage of flight reactions. When elk detect human disturbances, their first reaction was usually increased alertness, accompanied by an increase in heart rate. These data indicate the "range of disturbance" caused by humans is considerably greater than previous reports using "flight distance" techniques. Since heart rate is strongly correlated with metabolic rate, heart rate increases accompanying rapid flight indicate the use of large amounts of energy. Elk react most strongly to sonic booms, gunshots, people on foot, and stopped occupied vehicles. They show less concern for airplanes, steady traffic on interstate highways, and abandoned vehicles. In areas where elk are not able to hide or obtain security cover of trees or brush, the distances of effective response should be expected to be greater than in forested areas, particularly on open, alpine areas in early summer or the foothills and high meadow winter ranges, and open prairie. This could have a major effect upon location of hiking trails in the high alpine areas, including wilderness areas, on elk summer range and on human activities, such as cross-country skiing and snowmobiling on elk winter ranges. Campgrounds and centers of human activities where there are people walking around should be located over 800 m from elk use areas. Roads should be hidden in the trees and routed around well-used elk feeding sites.

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